# 4.1 WATER QUALITY AND PUBLIC HEALTH

This section describes the potential impacts of the proposed project on surface water and groundwater quality. Additionally, this section discusses the general water quality characteristics of surface water and groundwater and describes each hydrologic region in California. It discusses the beneficial uses of surface water and groundwater within each Regional Water Quality Control Board's (Regional Water Board's) jurisdiction. It presents a general discussion of relevant water quality issues as they pertain to onsite wastewater treatment systems (OWTS). This includes major OWTS pollutants of concern, a general overview of the physical and chemical characteristics that affect the fate and transport of those pollutants in the environment, and applicable objectives for improving or maintaining water quality. This section also addresses the proposed project's potential impacts on public health as a result of the interaction of OWTS-treated effluent with groundwater and surface water. For many of these topics, additional more-detailed information is provided in Appendix F, "Hydrology and Water Quality Technical Information."

Conventional OWTS systems work well for the removal of pathogens, and to a lesser extent some but not all other contaminants, when they are installed in areas with appropriate geology, soils, and hydrologic conditions. As discussed in this section, the amount of slope, soil permeability and texture, soil depths to impermeable soils, bedrock and groundwater, amount and frequency of rainfall, and distances from drinking water sources and surface water bodies are major factors when considering septic system placement and design and the system's associated environmental effects. Specific soil conditions, such as soil texture, soil structure, pH, salinity, temperature, oxygen, and moisture, affect the soil microorganisms that are essential for breaking down and decomposing wastewater effluent.

This section presents a range of representative conditions, including fractured rock and porous media settings, in relation to water quality characteristics and beneficial uses. This section discusses the effects of all the OWTS types covered by the proposed regulations on water quality. The potential impacts of the proposed project (i.e., the proposed statewide regulations) that are addressed include construction-related water quality impacts, such as installing, upgrading, or repairing OWTS; direct impacts on water quality or public health from OWTS operating adjacent to impaired surface water bodies as defined by the proposed regulations (discussed more below in "Approach and Methods"); direct and indirect impacts on water quality or public health from OWTS operating in areas other than those defined as impaired; and potential indirect impacts from increased septage pumping of biosolids. (The amount of biosolids does not increase to any significant extent.) These impacts are addressed for both conventional systems and systems with supplemental treatment units.

## 4.1.1 REGULATORY SETTING

As described in Chapter 3.0, "Regulatory Setting," a network of federal, state, and regional laws, rules, regulations, plans, and policies define the framework for regulating water quality for OWTS in California. The following discussion focuses on applicable water quality requirements.

### FEDERAL REGULATORY SETTING

The Federal Water Pollution Control Act of 1972 is also known as the Clean Water Act [CWA]. The CWA establishes the basic structure for regulation of discharges of pollutants to surface waters within the United States. It requires the states to adopt water quality standards and submit those standards for approval by the U.S. Environmental Protection Agency (EPA). The CWA authorizes EPA to delegate many permitting, administrative, and enforcement aspects of the law to state governments. In such cases, EPA still retains oversight responsibilities.

## STATE REGULATORY SETTING

### Porter-Cologne Water Quality Control Act and California Water Code

The Porter-Cologne Water Quality Control Act of 1969 (Porter-Cologne Act), codified as California Water Code Section 13000 et seq., is the primary water quality control law for California. For purposes of water quality regulation, the state is divided into nine regional watersheds, each governed by a Regional Water Quality Control Board (Regional Water Board) (Exhibit 2-4). The Regional Water Boards are the primary agencies responsible for protecting the quality of the state's surface water and groundwater. The State Water Resources Control Board (State Water Board) oversees water quality protection programs and is authorized by the California Water Code to adopt state policies regarding water quality, statewide water quality control plans, and regulations that are binding on the Regional Water Boards. In addition, the Porter-Cologne Act authorizes the Regional Water Boards to issue waste discharge requirements (WDRs), including National Pollutant Discharge Elimination System (NPDES) permits, and requires the Regional Water Boards to adopt water quality control plans (basin plans) for the protection of surface water and groundwater quality. The State Water Board may adopt water quality control plans for waters that have water quality standards required by the CWA.

A basin plan must:

- identify beneficial uses of surface water or groundwater to be protected,
- establish water quality objectives to ensure the reasonable protection of beneficial uses, and
- establish a program for implementing and achieving the water quality objectives.

Basin plans also provide the technical basis for issuing WDRs and thresholds and conditions for taking enforcement actions. Basin plans are required to be updated on a regular basis. Some of the types of water quality regulations contained in basin plans are described below as they relate to OWTS.

#### *Beneficial Uses*

Section 13050(f) of the Porter-Cologne Act defines "beneficial uses" as uses of waters of the state (i.e., surface water or groundwater) that must be protected against water quality degradation. The designated beneficial uses of surface water bodies are identified in the basin plans of each Regional Water Board. Potential beneficial uses include domestic, municipal, agricultural, and industrial water supply; power generation; recreation; aesthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves (Section 13050[f]). Most water bodies have multiple designated beneficial uses.

State Water Board policies have provided additional guidance regarding how the State Water Board and Regional Water Boards must regulate discharges to waters of the state in order to protect beneficial uses. In 1968, the State Water Board adopted Resolution 68-16, commonly referred to as the state Anti-degradation Policy. This policy established that all discharges to waters of the state must maintain background water quality unless it is to the maximum benefit of the people to do otherwise, but in no event can a discharge cause water quality objectives in basin plans to be exceeded.

In 1988, the State Water Board adopted Resolution 88-63, the Sources of Drinking Water Policy. This policy stated, "All surface and ground waters of the State are considered to be suitable, or potentially suitable, for municipal or domestic water supply and should be so designated by the Regional Boards…," with a few minor exceptions. Therefore, the State Water Board and Regional Water Boards regulate almost all surface water and groundwater of the state as a potential drinking water source. In accordance with basin plan requirements and Resolution 68-16, any discharges to groundwater must not exceed applicable water quality objectives.

Given the regulatory framework described above, the water quality and public health significance thresholds described below were applied in a manner that is compatible with this approach to compliance with water quality objectives used by the State Water Board and Regional Water Boards.

### *Water Quality Objectives*

California water quality objectives established in the basin plans protect surface water and groundwater quality. The objectives do this by governing the needed restrictions and limits on waste discharges (from sources such as OWTS) and on waters to which sources discharge. Exceedances of water quality objectives resulting from waste discharges would not protect the beneficial uses of the state's water resources.

Water quality objectives are numerical or narrative limits for constituents or characteristics of water. These limits are designed to protect beneficial uses of a body of groundwater or surface water. Narrative objectives describe water quality conditions that must be met and often provide the basis for further development of numerical objectives, which usually describe pollutant concentrations, physical and chemical conditions, and toxicity to organisms. Numeric water quality objectives established in Regional Water Board basin plans and narrative water quality objectives are summarized in Table 4.1-1.

**Table 4.1-1**
**Water Quality Objectives—Title 22 Drinking Water Standards Maximum Contaminant Levels (California and Federal)**

| Primary Wastewater Contaminants of Concern | MCL |
|---|---|
| **Nutrients (mg/l)** | |
| Nitrate (as $NO_3$) | 45 |
| Nitrate as Nitrogen (N) | 10 |
| Nitrite ($NO_2$) as Nitrogen (N) | 1 |
| Nitrate + Nitrite as Nitrogen (N) | 10 |
| **Pathogens (See Table 4.1-3)** | |
| Other Wastewater Contaminants of Concern | MCL |
| **Dissolved Inorganic Compounds (mg/l)** | |
| Chloride | 250 |
| Specific conductance (EC) | 900 umhos/cm |
| Sulfate | 250 |
| Total dissolved solids (TDS) | 500 |
| Arsenic [1] | 50 |
| Cadmium [1] | 5 |
| Copper | 1,000 |
| Iron | 300 |
| Lead [1] | 15 |
| Manganese | 50 |
| Mercury (inorganic) [1] | 2 |
| Nickel | 100 |
| Selenium | 50 |
| Silver | 100 |
| Zinc | 5,000 |
| Selected Organic Compounds (µg/L) | |
| 2,3,7,8-TCDD (Dioxin) [1] | 0.00003 |
| Chlordane [1] | 0.1 |
| gamma-BHC (Lindane) | 0.2 |
| Toluene | 150 |
| Trichloroethylene (TCE) | 5 |
| Xylene(s) | 1,750 |

Notes:
[1] Endocrine-disrupting compound (Colborn, Dumanoski, and Peterson Myers 2005)
MCL = maximum contaminant level; mg/l = milligrams per liter; µg/l = micrograms per liter.
Source: Data compiled by EDAW in 2008 from Title 22 of the California Code of Regulations, Section 64431

### *Total Maximum Daily Load Program*

As described in Chapter 3.0, "Regulatory Setting," Section 303(d) of the CWA requires that the states identify and establish a priority ranking for all the surface waters for which technology-based effluent limitations are not stringent enough to attain and maintain water quality standards. Section 303(d) requires states to develop a total maximum daily load (TMDL) program for each of the listed pollutants that are impairing an identified water body. A TMDL is a water quality control strategy that is included in the basin plan and is designed to address the impairment of a water body and to bring the water into compliance with water quality standards. A TMDL also addresses the quantity of a pollutant (the "loading") that the water body can receive and still be in compliance with water quality standards. TMDLs are adopted by Regional Water Boards as basin plan amendments and approved by the State Water Board. A TMDL must allocate allowable loadings to point and nonpoint sources and consider background loadings (loadings from natural sources under ambient conditions). The California Water Code requires that TMDLs include an implementation plan to reduce the loading of a specific pollutant from various sources to comply with water quality objectives. Permit limits contained in National Pollutant Discharge Elimination System permits must be consistent with the load allocation prescribed in the TMDL. The general categories of pollutants that are identified in the Section 303(d) list and may be present in OWTS effluent include pathogens (bacteria and viruses) and nutrients (e.g., nitrate). (For a complete listing of all 303(d)-listed pollutants of concern arranged according to Regional Water Boards—not only those related to OWTS—refer to Table F-1 in Appendix F, "Hydrology and Water Quality Technical Information.")

## California Safe Drinking Water Act

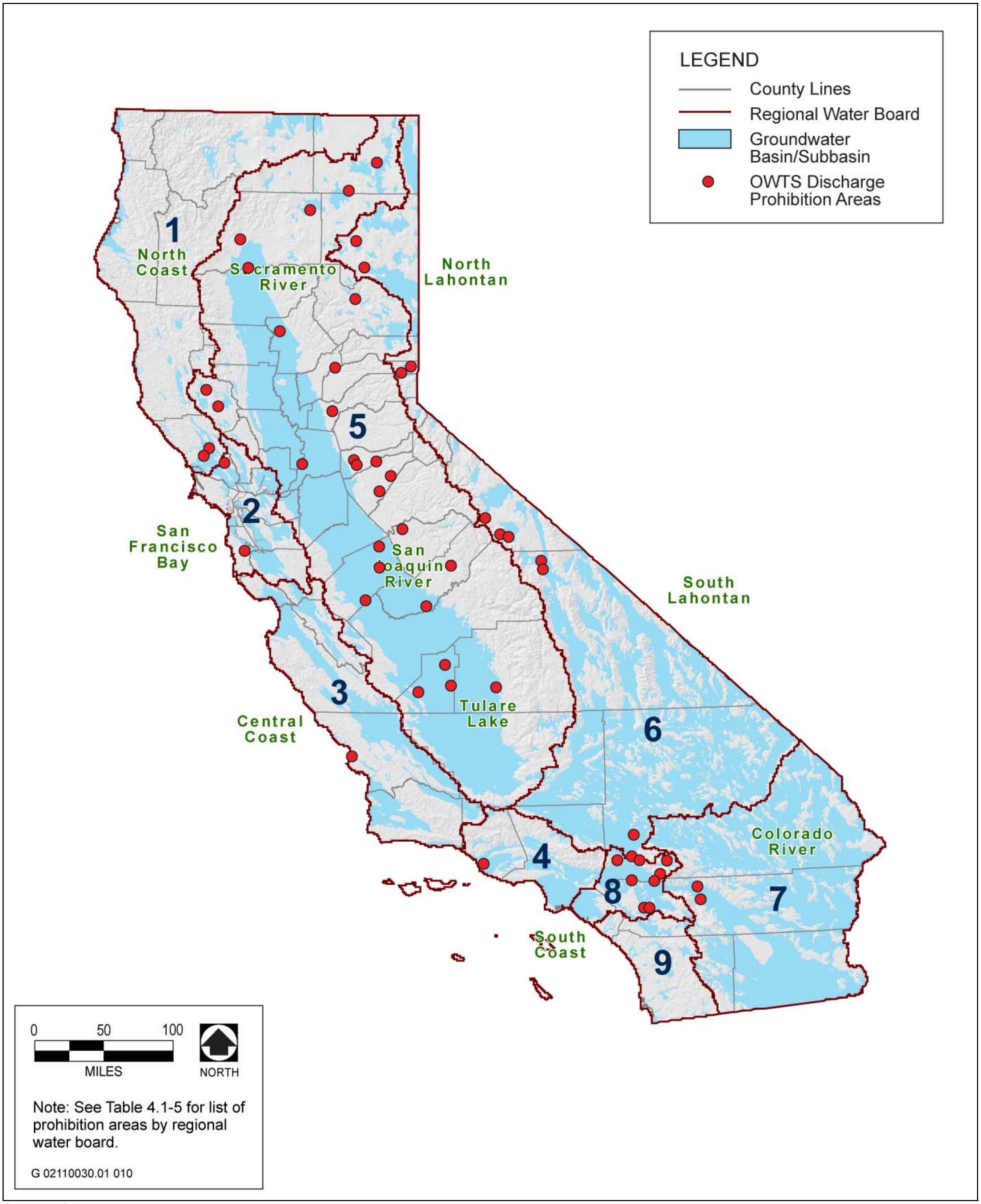
Maximum contaminant levels (MCLs) are components of the drinking water standards adopted by the California Department of Public Health (CDPH) under the California Safe Drinking Water Act. California primary and secondary MCLs are found in Title 22 of the California Code of Regulations (CCR), Division 4, Chapter 15, Domestic Water Quality and Monitoring. Primary MCLs are derived from health-based criteria (by CDPH from public health goals or from one-in-a-million [$10^{-6}$] incremental cancer risk estimates for carcinogens and threshold toxicity levels for noncarcinogens). MCLs are also based on technologic and economic considerations such as the feasibility of achieving and monitoring for these concentrations in drinking water supply systems and at the tap. Secondary MCLs are derived from aesthetic considerations (e.g., taste, odor, laundry staining) in the same manner as primary MCLs.

High concentrations of certain substances cause unpleasant tastes or odors in drinking water. Adverse tastes and odors may also be associated with nuisance conditions. Taste and odor thresholds are used to translate narrative water quality objectives that prohibit adverse tastes and odors in waters of the state and prohibit nuisance conditions. Taste and odor thresholds form the basis for many secondary drinking water MCLs. Both primary and secondary MCLs are incorporated into basin plans as water quality objectives for surface water and groundwater having the beneficial use designations of municipal and domestic supply.

## OWTS Discharge Prohibition Areas

The State Water Board and Regional Water Boards have broad jurisdiction to protect water quality in the state under the Porter-Cologne Act and delegated provisions of the federal Clean Water Act. Section 303(d) impaired surface water listing, WDRs, and TMDLs are important tools used to protect water quality and reduce contamination of waters of the state (both groundwater and surface waters). Where OWTS are specifically identified as being a primary source of contamination, another means of enforcing water quality standards is the adoption by Regional Water Boards of OWTS discharge prohibition areas (Exhibit 4.1-1).

Section 13243 of the California Water Code stipulates that a "Regional Water Board, in a water quality control plan or in waste discharge requirements, may specify certain conditions or areas where the discharge of waste, or certain types of waste, will not be permitted." Furthermore, Sections 13280, 13281, and 13283 of the California Water Code specifically address steps necessary for the Regional Water Boards to enact a prohibition of OWTS.




Source: State Water Board 2007

**OWTS Discharge Prohibition Areas** **Exhibit 4.1-1**

With this authority, the State Water Board may approve, revise, or deny adoption of a discharge prohibition area for OWTS for other discharges. An example of this is the Los Osos/Baywood Park Individual and Community Sewage Disposal System Prohibition Area (Resolution 83-13, Central Coast Regional Water Board), which was adopted after the Regional Water Board determined that septic systems were responsible for elevated coliform and nitrate levels in the watershed.

### LOCAL REGULATORY SETTING

The local regulatory setting for OWTS focuses on public health protection and differs widely throughout California. A broad overview of local regulatory information is provided in Chapter 3.0, "Regulatory Setting." Selected local regulations are described in Tables 3-1a and 3-1b for a range of California cities, counties, and districts.

## 4.1.2 WATER QUALITY AND PUBLIC HEALTH RISKS FROM OWTS

Many chemicals and pathogenic microorganisms are found in untreated or improperly treated sewage and can be a risk to public health (Table 2-5). In the case of OWTS, this may occur where people come in direct contact with surfacing effluent or through ingestion of contaminated foods or drinking water, recreational contact, or droplet spray.

Indirect contact may occur through contact with sewage-soiled clothing or tools, handling of pets that have had contact with sewage, or through vectors such as rodents or other organisms in contact with untreated sewage. Other indirect health effects may take place where vectors such as mosquitoes breed in surfacing effluent and may then carry diseases not related to sewage to human and animal populations.

Approximately 40% of the homes served by OWTS also draw their drinking water from groundwater located near the OWTS discharge (CWTRC 2003). State and tribal agencies identified OWTS as the third most common source of groundwater contamination, noting that inappropriate siting or design and/or inadequate long-term maintenance were the primary causes of failure (EPA 2002, 1996a). In the 1996 Clean Water Needs Survey (EPA 2002, 1996b), states and tribes also cited more than 500 communities that had experienced public health problems from failed septic systems. OWTS have been identified as a source of groundwater contamination resulting in diseases such as infectious hepatitis, typhoid fever, dysentery, and various gastrointestinal illnesses (EPA 1977).

More than half of all of the waterborne outbreaks and 45% of all cases of waterborne disease from 1971 to 1979 were caused by the consumption of untreated or inadequately treated groundwater. Of these cases, OWTS were determined to be responsible for 43% of the outbreaks and 63% of the illnesses. (Yates 1987; Craun 1984).

Despite the widespread acknowledgment of public health risks associated with OWTS, no statewide regulations have been enacted in California to address water quality protection from OWTS. Water quality parameters relating to specific public health concerns are described below.

### PATHOGENS

Pathogens can cause communicable diseases through direct and indirect body contact or ingestion of contaminated water or shellfish. A particular threat occurs when OWTS effluent pools on the ground surface or migrates to recreational waters. Some pathogens can travel substantial distances in groundwater or surface water. Pathogenic microorganisms found in domestic wastewater include a number of different bacteria, viruses, protozoa, and parasites that cause a wide range of gastrointestinal, neurological, respiratory, renal, and other diseases (Table 4.1-2). Infection can occur through ingestion (drinking contaminated water; incidental ingestion while bathing, skiing, or fishing), respiration, or contact. In susceptible populations, such as the very young, very old, pregnant, or immunocompromised, increased potential exists for serious illness or mortality. (EPA 2002, Gerba et al. 1996.) Other less common routes may include inhalation of spray droplets or contact through vectors (EPA 2002, Salvato 1992).

**Table 4.1-2**
**Waterborne Pathogens Found in Human Waste and Associated Diseases**

| Type | Organism | Disease | Effects |
|---|---|---|---|
| **Bacteria** | *Escherichia coli* (enteropathogenic) | Gastroenteritis | Vomiting, diarrhea, death in susceptible populations (elderly, infants, pregnant, immunocompromised) |
| | *Legionella pneumophilia* | Legionellosis | Acute respiratory illness |
| | *Leptospira* | Leptospirosis | Jaundice, fever (Well's disease) |
| | *Salmonella typhi* | Typhoid fever | High fever, diarrhea, ulceration of the small intestine |
| | *Salmonella* | Salmonellosis | Diarrhea, dehydration |
| | *Shigella* | Shigellosis | Bacillary dysentery |
| | *Vibrio cholerae* | Cholera | Extremely heavy diarrhea, dehydration |
| | *Yersinia enterolitica* | Yersinosis | Diarrhea |
| **Protozoa** | *Balantidium coli* | Balantidiasis | Diarrhea, dysentery |
| | *Cryptosporidium* | Cryptosporidiosis | Diarrhea |
| | *Entamoeba histolytica* | Amoebiasis (amoebic dysentery) | Prolonged diarrhea with bleeding, abscesses of the liver and small intestine |
| | *Giardia lamblia* | Giardiasis | Mild to severe diarrhea, nausea, indigestion |
| | *Naegleria fowleri* | Amoebic meningoencephalitis | Fatal disease; inflammation of the brain |
| **Viruses** | Adenovirus (31 types) | Conjunctivitis | Eye, other infections |
| | Enterovirus (67 types, e.g., polio, echo, coxsackie viruses) | Gastroenteritis | Heart anomalies, meningitis |
| | Hepatitis A | Infectious hepatitis | Jaundice, fever |
| | Norwalk agent | Gastroenteritis | Vomiting, diarrhea |
| | Reovirus | Gastroenteritis | Vomiting, diarrhea |
| | Rotavirus | Gastroenteritis | Vomiting, diarrhea |

Source: EPA 1999 (as cited in EPA 2002).

The health risks associated with surfacing sewage, or the degradation of groundwater or surface water, relate to the exposure of persons either through ingestion or contact and environmental factors affecting the viability of the pathogenic microorganisms in the sewage. Many factors are involved in estimating such risks, including the concentration of organisms, soil attenuation, saturated or unsaturated soil conditions, pH, temperature, humidity, nutrients, and others. Life spans of specific microorganisms in soils may vary from days to years depending on environmental conditions. Approximately 40% of the homes served by OWTS also draw their drinking water from groundwater located near an OWTS discharge (CWTRC 2003). With groundwater at depths of 3–5 feet, soil attenuation can promote die-off of bacteria and viruses up to 99.99%. Under other conditions, pathogens have been known to travel long distances in both groundwater and surface water (EPA 2002; Siegrist, Tyler, and Jenssen 2000).

## Bacteria

Bacteria are single-celled microscopic organisms whose cells have no true nuclei. Among pathogenic agents, only bacteria have any potential to reproduce and multiply between, as opposed to within, hosts (EPA 2002). Many kinds of bacteria live in the human digestive tract, and human excrement is a primary source of bacteria in domestic wastewater. Very high concentrations of bacteria of many kinds are contained in domestic wastewater, most of which are not pathogenic; that is, they do not cause or produce disease. However, some bacteria that may be found in domestic wastewater can be pathogenic and are a major public health concern. The primary bacterial agents contributing to waterborne illnesses nationwide are shown in Table 4.1-2. In an optimally functioning OWTS dispersal field (depicted in Exhibit 2-1), the retention and die-off of most, if not all, observed pathogenic bacterial indicators occurs within 2–3 feet of the infiltrative surface (Anderson et al. 1994; Ayres Associates 1993a, 1993b; Bouma et al. 1972; McGaughey and Krone 1967). With a mature biomat at the infiltrative surface of coarser soils, most bacteria are removed within the first 1 foot vertically or horizontally from the trench-soil interface (University of Wisconsin 1978). Failure to properly site, design, install, and/or operate and maintain OWTS can result in the introduction of potentially pathogenic bacteria into groundwater or surface water. Discharges to surface waters may result in designation of impairment under Section 303(d). Water quality objectives have been established by all nine Regional Water Boards to address bacteria concentrations in groundwater and surface water (Table 4.1-3).

## Protozoa and Helminthes

Pathogenic protozoa (single-celled animals), helminthes (parasitic worms), and their eggs are sometimes present in domestic wastewater. If ingested by humans, these can cause illnesses that range from minor gastrointestinal episodes to the very serious effects of *Cryptosporidium* (Table 4.1-2). If pathogenic protozoa reach groundwater, they can present a contamination risk if the water is ingested without disinfection. Protozoa are generally an order of magnitude larger than bacteria and often feed on bacteria (Wisconsin Department of Commerce 1998).

## Viruses

Viruses are composed of a nucleic acid core (either deoxyribonucleic acid [DNA] or ribonucleic acid [RNA]) surrounded by an outer shell of protein called a capsid. Viruses are obligate intracellular parasites; they multiply only within a host cell, where they redirect the cell's biochemical system to reproduce themselves. Viruses can also exist in an extracellular state in which the virus particle (known as a virion) is metabolically inert. Viruses are not a normal part of the fecal flora. They occur in infected persons, and they appear in septic tank effluent intermittently, in varying numbers, reflecting the combined infection and carrier status of OWTS users (Berg 1973). It is estimated that less than 1–2% of the stools excreted in the United States contain enteric viruses (University of Wisconsin 1978), although episodic breakthroughs of virus and bacteria can occur in OWTS (EPA 2002). Therefore, such viruses are difficult to monitor and little is known about their frequency of occurrence and rate of survival in conventional OWTS and OWTS with supplemental treatment units. Common viruses that appear in wastewater are listed in Table 4.1-2.

In a study by Hinkle et al. (2005), in samples from wells located downgradient from OWTS drainfield lines at an Oregon site, coliphage (viruses that infect coliform bacteria and that are found in high concentrations in municipal wastewater) were occasionally detected at low concentrations. These concentrations were below method detection limits; however, they were in replicate or repeat samples collected from the sites. Data indicate that coliphage were effectively attenuated over distances of several feet of transport in the underlying aquifer and/or overlying unsaturated zone. Viruses have been known to persist in soil for up to 125 days and travel in groundwater for distances up to 1,339 feet. Viruses are less affected by infiltration than bacteria (EPA 2002).

**Table 4.1-3**
**Water Quality Objectives Addressing Bacteria or Pathogens**

| North Coast (Region 1) | San Francisco Bay (Region 2) | Central Coast (Region 3) | Los Angeles (Region 4) | Central Valley (Region 5) | Lahontan (Region 6) | Colorado River Basin (Region 7) | Santa Ana (Region 8) | San Diego (Region 9) |
|---|---|---|---|---|---|---|---|---|
| **GROUNDWATER** | | | | | | | | |
| In groundwaters used for domestic or municipal supply (MUN), the median of the most probable number of coliform organisms over any 7-day period shall be less than 1.1 most probable number (MPN)/100 milliliters (ml), less than 1 colony/100 ml, or absent. | In groundwater with a beneficial use of municipal and domestic supply (MUN), the median of the most probable number of coliform organisms over any 7-day period shall be less than 1.1 MPN/100 ml. | The median concentration of coliform organisms over any seven-day period shall be less than 2.2/100 ml. | In groundwater used for domestic or municipal supply (MUN) the concentration of coliform organisms over any seven day period shall be less than 1.1/100 ml. | In ground waters used for domestic or municipal supply (MUN) the most probable number of coliform organisms over any seven-day period shall be less than 2.2/100 ml. | In ground waters designated as MUN, the median concentration of coliform organisms over any seven-day period shall be less than 1.1/100 ml. | In ground waters designated for use as domestic or municipal supply (MUN), the concentration of coliform organisms shall not exceed the limits specified in California Code of Regulations, Title 22, Chapter 15, Article 3. | Total coliform numbers shall not exceed 2.2 organisms/ 100 ml median over any seven-day period in groundwaters designated MUN as a result of controllable water quality factors. | Bacteria water quality objectives are the same for groundwaters as for surface waters (see below). |
| **SURFACE WATER** | | | | | | | | |
| The bacteriologic quality of waters of the North Coast Region shall not be degraded beyond natural background levels. In no case shall coliform concentrations in waters of the North Coast Region exceed the following:<br>In waters designated for contact recreation (REC-1), the median fecal coliform concentration based on a minimum of not less than five samples for any 30-day period shall not exceed 50/100 ml, nor shall more than 10% of total samples during any 30-day period exceed 400/100 ml (State Department of Health Services). | The bacteria water quality objectives for surface water are found in Table 3-1 "Water Quality Objectives for Coliform Bacteria" and Table 3-2 "U.S. EPA Bacteriological Criteria for Water Contact Recreation" in San Francisco Bay Regional Water Quality Control Board, 1995. | For REC l, fecal coliform concentration, based on a minimum of not less than five samples for any 30-day period, shall not exceed a log mean of 200/100 ml, nor shall more than 10% of total samples during any 30-day period exceed 400/100 ml. | In Marine Waters Designated for Water Contact Recreation (REC-1)<br>1. Geometric Mean Limits<br>a. Total coliform density shall not exceed 1,000/100 ml.<br>b. Fecal coliform density shall not exceed 200/100 ml.<br>c. Enterococcus density shall not exceed 35/100 ml.<br>2. Single Sample Limits<br>a. Total coliform density shall not exceed 10,000/100 ml.<br>b. Fecal coliform density shall not exceed 400/100 ml.<br>c. Enterococcus density shall not exceed 104/100 ml.<br>d. Total coliform density shall not exceed 1,000/100 ml, if the ratio of fecal-total coliform exceeds 0.1. | In waters designated for contact recreation (REC-1), the fecal coliform concentration based on a minimum of not less than five samples for any 30-day period shall not exceed a geometric mean of 200/100 ml, nor shall more than 10% of the total number of samples taken during any 30-day period exceed 400/100 ml. For Folsom Lake (50), the fecal coliform concentration based on a minimum of not less than five samples for any 30-day period, shall not exceed a geometric mean of 100/100 ml, nor shall more than 10% of the total number of samples taken during any 30-day period exceed 200/100 ml. | Waters shall not contain concentrations of coliform organisms attributable to anthropogenic sources, including human and livestock wastes. The fecal coliform concentration during any 30-day period shall not exceed a log mean of 20/100 ml, nor shall more than 10% of all samples collected during any 30-day period exceed 40/100 ml. The log mean shall ideally be based on a minimum of not less than five samples collected as evenly spaced as practicable during any 30-day period. However, a log mean concentration exceeding 20/100 ml for any 30-day period shall indicate violation of this objective even if fewer than five samples were collected. | In waters designated for water contact recreation (REC I) or noncontact water recreation (REC II), the following bacterial objectives apply. Although the objectives are expressed as fecal coliforms, Escherichia coli (E. coli), and enterococci bacteria, they address pathogenic microorganisms in general (e.g., bacteria, viruses, and fungi). Based on a statistically sufficient number of samples (generally not less than five samples equally spaced over a 30-day period), the geometric mean of the indicated bacterial densities should not exceed one or the other of the following in footnote (A). | Ocean Waters. REC-1: Fecal coliform: log mean less than 200 organisms/ 100 ml based on five or more samples/30-day period, and not more than 10% of the samples exceed 400 organisms/100 ml for any 30-day period. SHEL: Fecal coliform: median concentration not more than 14 MPN (most probable number) /100 ml and not more than 10% of samples exceed 43 MPN/100 ml. | In waters designated for contact recreation (REC-1), the fecal coliform concentration based on a minimum of not less than five samples for any 30-day period, shall not exceed a log mean of 200/100 ml, nor shall more than 10% of total samples during any 30-day period exceed 400/100 ml. In waters designated for non-contact recreation (REC-2) and not designated for contact recreation (REC-1), the average fecal coliform concentrations for any 30-day period, shall not exceed 2,000/100 ml nor shall more than 10% of samples collected during any 30-day period exceed 4,000/100 ml. |
| At all areas where shellfish may be harvested for human consumption (SHELL), the fecal coliform concentration throughout the water column shall not exceed 43/100 ml for a 5-tube decimal dilution test or 49/100 ml when a three-tube decimal dilution test is used (National Shellfish Sanitation Program, Manual of Operation). | | For REC ll, fecal coliform concentration, based on a minimum of not less than five samples for any 30-day period, shall not exceed a log mean of 2,000/100 ml, nor shall more than 10% of samples collected during any 30-day period exceed 4,000/100 ml. | In Fresh Waters Designated for Water Contact Recreation (REC-1)<br>1. Geometric Mean Limits<br>a. E. coli density shall not exceed 126/100 ml.<br>b. Fecal coliform density shall not exceed 200/100 ml.<br>2. Single Sample Limits<br>a. E. coli density shall not exceed 235/100 ml.<br>b. Fecal coliform density shall not exceed 400/100 ml. | | | In addition to the objectives above, in waters designated for water contact recreation (REC I), the fecal coliform concentration based on a minimum of not less than five samples for any 30-day period, shall not exceed a log mean of 200 MPN per 100 ml, nor shall more than 10% of total samples during any 30-day period exceed 400 MPN per 100 ml. | Enclosed Bays and Estuaries. REC-l: Fecal coliform: log mean less than 20 organisms/100 ml based on five or more samples/30 day period, and not mare than 10% of the samples exceed 400 organisms per 100/ml for any 30-day period. SHELL: Fecal coliform: median concentration not more than 14 MPN /100 ml and not more than 10% of samples exceed 43 MPN/100 ml. | In waters where shellfish harvesting for human consumption, commercial or sports purposes is designated (SHELL), the median total coliform concentration throughout the water column for any 30-day period shall not exceed 70/100 ml nor shall more than 10% of the samples collected during any 30-day period exceed 230/100 ml for a five-tube decimal dilution test or 330/100 ml when a three-tube decimal dilution test is used. |

**Table 4.1-3**
**Water Quality Objectives Addressing Bacteria or Pathogens**

| North Coast (Region 1) | San Francisco Bay (Region 2) | Central Coast (Region 3) | Los Angeles (Region 4) | Central Valley (Region 5) | Lahontan (Region 6) | Colorado River Basin (Region 7) | Santa Ana (Region 8) | San Diego (Region 9) |
|---|---|---|---|---|---|---|---|---|
| | | | In all waters where shellfish can be harvested for human consumption (SHELL), the median total coliform concentration throughout the water column for any 30.day period shell not exceed 70/100 ml, nor shall more than 10% of the samples collected during any 30-day period exceed 230/100 ml for a five-tube decimal dilution test or 330/100 ml when a three-tube decimal dilution test is used. | | | | Inland Surface Waters. MUN: Total coliform: less than 100 organisms/100 ml. REC-l Fecal coliform: log mean less than 200 organisms/100 ml based on five or more samples/30 day period, and not more than 10% of the samples to exceed 400 organisms/ 100 ml for any 30 day period. REC-2 Fecal coliform: average less than 2000 organisms/l00 ml, and not more than 10% of samples exceed 4,000 organisms/100 ml, for any 30-day period. | In bays and estuaries, the most probable number of coliform organisms in the upper 60 feet of the water column shall be less than 1,000 per 100 ml (10 per ml); provided that not more than 20% of the samples at any sampling station, in any 30-day period, may exceed 1,000 per 100 ml (10 per ml), and provided further that no single sample when verified by a repeat sample taken within 48 hours shall exceed 10,000 per 100 (100 per ml). |
| | | | For Santa Monica Bay Beaches, see California Regional Water Quality Control Board, Los Angeles Region Resolution No. 2002-022, December 12, 2002 “Amendment to the Water Quality Control Plan (Basin Plan) for the Los Angeles Region to Incorporate Implementation Provisions for the Region’s Bacteria Objectives and to Incorporate a Wet Weather Total Maximum Daily Load for Bacteria at Santa Monica Bay Beaches” | | | | | In San Diego Bay where bay waters are used for whole fish handling, the density of E. coli shall not exceed 7 per ml in more than 20% of any 20 daily consecutive samples of bay water. |

(A) Colorado (Region 7) Surface Water Bacteria Water Quality Objectives

| | REC I | REC II |
|---|---|---|
| E. coli | 126 per 100 ml | 630 per 100 ml |
| enterococci | 33 per 100 ml | 165 per 100 ml |
| nor shall any sample exceed the following maximum allowables: | | |
| E. coli | 400 per 100 ml | 2000 per 100 ml |
| enterococci | 100 per 100 ml | 500 per 100 ml |
| except that for the Colorado River, the following maximum allowables shall apply: | | |
| E. coli | 235 per 100 ml | 1175 per 100 ml |
| enterococci | 61 per 100 ml | 305 per 100 ml |

Source: Data compiled by EDAW in 2008 using the water quality control plans for the Central Valley, North Coast, San Francisco Bay, Central Coast, Lahontan, Los Angeles, Santa Ana, San Diego, and Colorado River Regional Water Quality Control Boards

## NITROGEN

Nitrogen is an essential plant nutrient and a fundamental component of proteins and other constituents of living matter. Nitrogen fixation is the process whereby nitrogen gas, unavailable to plants in its elemental form, is converted to organic nitrogen compounds available for assimilation by plants. The nitrogen cycle describes the movement of fixed nitrogen through the four major nitrogen reservoirs: atmospheric, the largest reservoir; oceanic; terrestrial soils, where over 90% of the nitrogen content is organic (e.g., bound to soil humus); and the underlying geologic strata where, unlike potassium and phosphate, nitrogen is not a significant product of mineral weathering. Natural sources of nitrogen fixation are lightning, biological nitrogen fixation by cyanobacteria in soil and water, and *Rhizobium* bacteria living in the root nodules of a wide variety of plant species. The other major source of biologically available nitrogen is human-induced activity, which now accounts for 30–40% of all fixed nitrogen (Manahan 1994). Human activities resulting either directly or indirectly in bioavailable nitrogen loading include chemical fertilizer manufacture and application, release of fixed nitrogen during fuel combustion, increased cultivation of nitrogen-fixing legume crops, and agricultural runoff and waste discharges from higher biological organisms (e.g., livestock, humans, wildlife), including OWTS.

The most generally available nitrogen compound for plants is the nitrate ion, $NO_3^-$. This is the nitrogen compound generally found in groundwater (State Water Board 1988). The drinking water standard for nitrate-N (the weight of the nitrogen content of the nitrate ion, i.e., nitrate as nitrogen) is 10 milligrams per liter (mg/l) (Table 4.1-1). Nitrate is sometimes expressed as the ionic weight of the nitrate ion per unit volume, which results in a concentration approximately 4.5 times higher than that of nitrate-N, or 45 mg/l. This chapter will refer to the nitrate-N form and drinking water standard of 10 mg/l. Excessive levels of nitrate-N in drinking water can cause “blue baby syndrome” or methemoglobinemia in infants and pregnant women, and other human and ecological problems (Pierzynski et al. 2000). Nitrogen in wastewater is generally present as organic nitrogen (i.e., nitrogen combined in organic molecules such as amino acids, proteins, and polypeptides) or ammonia. Nitrate ($NO_3^-$) and nitrite ($NO_2^-$) are two oxidized forms of inorganic nitrogen and are key factors in the nitrogen cycle and in aquatic environments. Total nitrogen concentrations in domestic septic tank effluent are in the range of 40–100 mg/l (EPA 2002).

Conventional OWTS can remove only 10–20% nitrogen from septic tank effluent. Most nitrogen in wastewater is organic and becomes transformed to nitrate in the soil (or by an aerobic supplemental treatment unit) before discharge. The resulting concentration of nitrate beneath the OWTS can range between 32–90 mg/l in groundwater (EPA 2002). As previously noted, approximately 40% of the homes served by OWTS also draw their drinking water from groundwater located near an OWTS discharge (CWTRC 2003). A primary pathway of exposure to high levels of nitrate is through ingestion of drinking water contaminated by nitrates at levels that exceed water quality standards.

Nitrogen can undergo several transformations in and below an OWTS, including adsorption, volatilization (or evaporation), mineralization, nitrification, and denitrification. Nitrification, the conversion of ammonium nitrogen to nitrite and then to nitrate by bacteria under aerobic conditions, is the predominant transformation that occurs immediately below the infiltration zone. When nitrate from the OWTS discharge reaches groundwater, it moves freely with little attenuation, because the negatively charged nitrate ion is very soluble and moves readily with groundwater flow. Denitrification is a microbial process whereby nitrate is reduced mostly to nitrogen gas that escapes to the atmosphere. Denitrification rates have been found to be significant in the saturated zone only in rare instances where carbon or sulfur deposits are present. In those cases where a suitable reservoir of electron donor constituents exists, (e.g., trace quantities of organic carbon, sulfide minerals or ferrous iron), these aquifers may be substantially less at risk from nitrate contamination than other aquifers (Siegrist, Tyler, and Jenssen 2000). In general though, reduction of nitrate concentrations in groundwater primarily occurs through dispersion in groundwater supplies (EPA 2002). Thus, in most instances OWTS effluent would require removal of nitrogen before being discharged to the soil that makes up the dispersal field to meet the 10 mg/l water quality objective for nitrogen (and drinking water standard).

Because total nitrogen is typically only reduced 10–20% in a conventional OWTS, studies have shown high nitrate concentrations in groundwater plumes hundreds of feet downgradient from the OWTS. It must be assumed that nearby groundwater wells are at risk of being affected by levels of nitrate from OWTS in excess of water quality standards. Denitrification technologies added to an OWTS can reduce effluent concentrations of nitrate-N to levels near 10 mg/l, the current California drinking water standard. (EPA 2002; Siegrist, Tyler, and Jenssen 2000; Robertson 1991)

Eutrophication (algal blooms) describes a condition of excess nutrient (and phosphorus) enrichment, and has been identified as one of the leading causes of surface water quality impairment in the United States today (EPA 1996b). Typical problems associated with eutrophic waters are increased growth of undesirable algae and aquatic weeds; low dissolved oxygen levels after the death of algal blooms and nuisance aquatic weeds, which in turn can result in fish kills; increased turbidity and decreased light penetration through the water column that eventually leads to the loss of benthic plant and animal communities; sedimentation, which negatively affects navigational and recreational uses of surface waters; and increased incidences of foul odors, surface scums, unpalatable drinking waters, and nuisance insect problems (EPRI 2001). (Additional discussion of the effects of nitrogen on plants and wildlife is provided in Section 4.2 “Biological Resources.”)

### PHOSPHORUS

Phosphorus is an aquatic plant nutrient that can also contribute to eutrophication (algal blooms) of inland and coastal surface waters and reduction of dissolved oxygen. In contrast to some forms of nitrogen, phosphorus is not directly toxic to humans, but has been shown to be involved in several water quality problems related to eutrophication that can affect human or animal health. Examples include the formation of carcinogenic trihalomethanes during the chlorination of waters that have recently experienced algal blooms (Kotak et al. 1994); consumption by livestock or humans of waters containing cyanobacteria blooms or the neuro- and hepatotoxins released when these blooms die (Martin and Cooke 1994); and, most recently, the effect on human health of neurotoxins and other toxic constituents released by dinoflagellates, such as *Pfiesteria piscicida*, that bloom in phosphorus-limited eutrophic coastal waters (Burkholder and Glasgow 1997). (Additional discussion of the effects of phosphorus on plants and wildlife is provided in Section 4.2, “Biological Resources.”)

### ORGANIC COMPOUNDS

Organic compounds are present in many routine household chemicals, cleaning products and solvents, and components of pharmaceuticals and personal care products that include human prescription and nonprescription medical drugs and caffeine. Potential negative health effects include neurological and developmental problems, and cancer (Table 4.1-4). In addition, concentrations of these chemicals may affect some functions of both conventional and supplemental treatment systems, causing indirect effects such as a reduction in treatment of specific pollutants. The primary pathways of exposure would be through ingestion of drinking water contaminated by organic chemicals, direct contact with water, such as bathing or swimming, and respiration of droplets from bathing or other aerosols.

Organic compounds can be persistent in groundwater and surface water. Some accumulate and concentrate in ecosystem food chains. Commonly used surfactants (or foaming agents) are linear alkylbenzene sulfonate (LAS), alcohol ethoxylate (AE), and alcohol ether sulfate (AES). They are readily removed via biodegradation in septic systems or sorption onto soils, even under worst-case conditions (Nielsen et al. 2002). As an example of persistence in the environment, Gamma-BHC, commonly called Lindane, is an isomer (one of several chemical forms) of the chemical hexachlorocyclohexane (HCH) and is used as an insecticide on fruit, vegetables, and forest crops. It is also used as a lotion, cream, or shampoo to treat head and body lice and scabies. It is banned in many, but not all countries. Lindane has not been produced in the United States since 1976 but continues to be imported for insecticide use (ATSDR 2004).

| Table 4.1-4<br>**Maximum Contaminant Levels for Selected Organic Compounds in Drinking Water** | | |
|---|---|---|
| Compound | MCL (mg/l) | Potential Health Effects |
| Benzene | 0.005 | Anemia; decrease in blood platelets; increased risk of cancer |
| Chlordane | 0.002 | Liver or nervous system problems; increased risk of cancer |
| Chlorobenzene | 0.1 | Liver or kidney problems |
| 2,4-D | 0.07 | Liver, kidney, or adrenal gland problems |
| o-Dichlorobenzene | 0.6 | Liver, kidney, or circulatory system problems |
| 1,2-Dichloroethane | 0.005 | Increased risk of cancer |
| Dichloromethane | 0.005 | Liver problems, increased risk of cancer |
| Dioxin | 0.00000003 | Reproductive difficulties; increased risk of cancer |
| Ethylbenzene | 0.7 | Liver or kidney problems |
| Hexachlorobenzene | 0.001 | Liver or kidney problems; reproductive difficulties; increased risk of cancer |
| Lindane | 0.0002 | Liver or kidney problems |
| Toluene | 1.0 | Nervous system, kidney, or liver problems |
| Trichloroethylene | 0.005 | Liver problems; increased risk of cancer |
| Vinyl chloride | 0.002 | Increased risk of cancer |
| Xylenes (total) | 10 | Nervous system damage |

Notes:
MCL = maximum contaminant level; mg/l = milligrams per liter.
Source: EPA 2000 (as cited in EPA 2002)

Surfactants, or foaming agents, are commonly used in laundry detergents and other soaps to decrease the surface tension of water and increase wetting and emulsification. Surfactants are the largest class of human-produced organic compounds present in raw domestic wastewater. They can be found in most domestic septic system effluents (Wisconsin Department of Commerce 1998, EPA 2002). Surfactant molecules contain both strongly hydrophobic (not easily mixing with water) and strongly hydrophilic (easily mixing with water) properties and thus tend to concentrate at interfaces where water meets air, oily material, and particles.

Hinkle et al. (2005) found nine organic wastewater compounds in more than 90% of groundwater samples from a monitoring network downgradient of OWTS dispersal system effluent:

- acetyl-hexamethyl-tetrahydro-naphthalene (AHTN)
- caffeine
- cholesterol
- hexahydrohexamethyl-cyclopentabenzopyran
- N,N-diethyl-meta-toluamide (DEET)
- tetrachloroethene
- tris (2-chloroethyl) phosphate
- tris (dichloroisopropyl) phosphate
- tributyl phosphate

Detection of these compounds provides evidence that some of them may be useful indicators of human waste effluent dispersal in some hydrologic environments.

Studies have shown mixed results regarding removal of organic compounds using conventional OWTS. Reductions depend on the chemical type and a multitude of environmental factors. Although several studies found complete or nearly complete removal of organic compounds below OWTS (EPA 2002; Ayres Associates 1993a, 1993b; Robertson 1991; Sauer and Tyler 1991), other studies found variable results in the potential for such chemicals to reach and flow with groundwater (EPA 2002). Studies have indicated that the common LAS, AE, and AES surfactants are readily removed from groundwater in soils below the soil dispersal fields, even in situations with minimal unsaturated soil zones. The most successful processes for removing these surfactants are likely biodegradation and sorption (EPA 2002, Nielsen et al. 2002). Surfactants do not usually create public health concerns, although methylene blue active substances, common in household laundry detergent, can affect the aesthetic quality of water if present in significant quantities by inducing foaming. No investigations have been found that identify cationic or nonionic surfactants in groundwater that originated from soil dispersal fields (WI DOC 1998, EPA 2002). However, with the unpredictability of removal, groundwater contamination must be assumed to be taking place in some specific cases. Factors involved in the fate and transport of organic compounds are described in Section 4.1.3.4, “Factors Affecting the Fate and Transport of OWTS Pollutants of Concern.”

### METALS

Some metals in drinking water may cause human health problems. Metals including lead, mercury, cadmium, copper, and chromium can cause physical and mental developmental delays, kidney disease, gastrointestinal illnesses, and neurological problems (DeWalle et. al. 1985). In the aquatic ecosystem, they are also toxic to aquatic life and accumulate in fish and shellfish that might be consumed by humans. Metals can be present in raw household wastewater from commonly used household products; aging interior plumbing systems that can contribute lead, cadmium, and copper; foodstuffs; and human waste (EPA 2002).

Several EPA priority pollutant metals have been found in domestic septic tank effluent (including nickel, lead, copper, zinc, barium, and chromium), although at low concentrations. Copper and zinc were the only trace metals found in any significant amounts, and those concentrations were less than in tap water (Whelan and Titmanis 1982). Reviews and studies to date, although not extensive, have suggested there is very little concern over heavy metals in domestic septic tank effluent (Siegrist, Tyler, and Jenssen 2000). The fate of metals in soil is varies and depends on complex physical, chemical, and biochemical interactions. Although studies appear to indicate possible removal in both the septic tank and soils, some risk remains and groundwater contamination in specific cases is possible (EPA 2002).

The primary processes controlling the fixation or mobility of metals in subsurface infiltration systems are adsorption onto negatively charged soil particles and interaction with organic molecules. The solubility of metals is pH dependent and tends to be lowest between pH 6 and 8. Acidic conditions can reduce the sorption of metals in soils, leading to increased solubility and therefore increased risk of groundwater contamination (Evanko and DZombak 1997, EPA 2002). Factors involved in the fate and transport of heavy metals are described briefly in “Physical and Chemical Characteristics of Contaminants in OWTS Effluent.” For more detail on specific heavy metals (lead, mercury, cadmium, copper, chromium, arsenic, and zinc), their sources, and their methods of removal from solution, see Appendix F, “Hydrology and Water Quality Technical Information.”

### DISSOLVED INORGANIC COMPOUNDS

Chloride and sulfide cause taste and odor problems in drinking water. Sodium and to a lesser extent potassium can be deleterious to soil structure and OWTS dispersal system performance, although normal or conservative residential uses of salts and household bleaches are not detrimental to the microbial population (Bounds 1997). Sodium is commonly present in background levels in groundwater. However, the sodium concentration is considerably higher in discharges from an OWTS when the OWTS receives discharge from water softeners. Concentrations of boron and calcium in septic tank effluent typically reflect those found in the water supply source. Major natural sources of sulfate in drinking water are from oxidation of metallic sulfide compounds (such as FeS) found in bedrock. Domestic wastewater contains additional sulfate concentrations from the oxidation of reduced sulfur compounds present in fecal matter. Higher concentrations of sulfate in OWTS effluent will typically be a function of the natural water quality of the region. In general, dissolved inorganic compounds may affect the soil structure and function, which may subsequently reduce the effectiveness of the soil to treat OWTS effluent before it reaches groundwater.

### ENDOCRINE-DISRUPTING COMPOUNDS

The presence of common hormones, drugs, and chemicals from personal care products (e.g., shampoo, cleaning products, and pharmaceutical products) in wastewater and receiving water bodies is an emerging water quality and public health concern. Endocrine-disrupting compounds (EDCs) are substances that alter the function of the endocrine (secretions, such as hormones, distributed through the body by way of the bloodstream) system and consequently cause adverse health effects on exposed organisms or their offspring. EDCs may be present in such common items as medicines, over-the-counter therapeutics, pesticides, soaps, shampoos, hair colors, plastics and plasticizers, polychlorinated biphenyls (PCBs), spermicides, preservatives, and specific metals. Only recently has the presence of EDCs been recognized in water bodies of the United States at a high frequency; however, measured concentrations have been low and usually below drinking water standards (in the cases of those compounds for which standards have been established). Specific studies have found EDCs in sufficient quantity that they could potentially cause endocrine disruption in some fish.

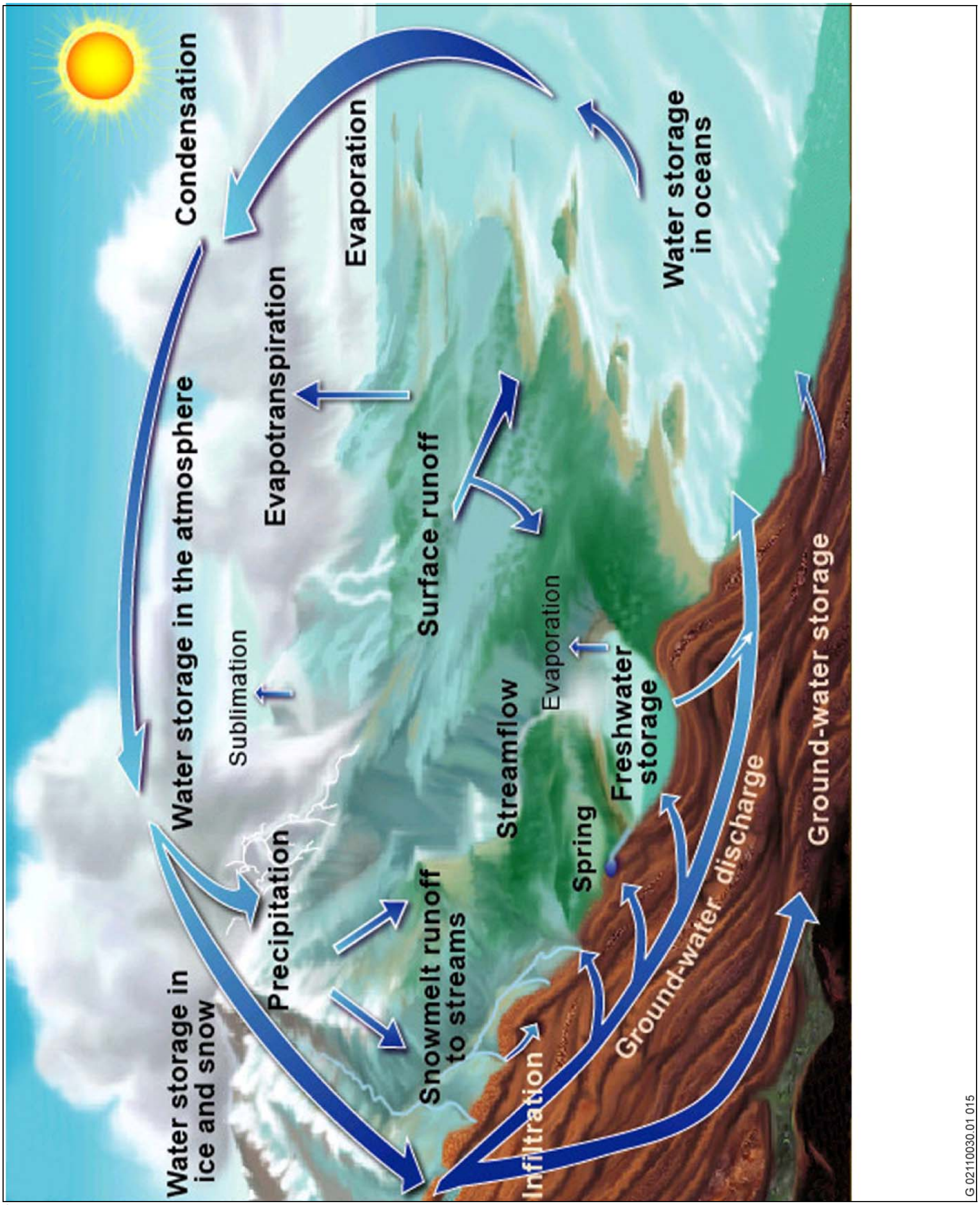
The extent of human health risks and dose responses to EDCs in concentrations at the low levels found in the environment are still unknown. The specific category of EDCs includes both natural compounds, such as phytoestrogens, and synthetic chemicals, which are of increased concern. Congress has directed EPA to study the transmission of EDCs through drinking water. Some of these have been implicated in accelerating the growth of breast cancer cell cultures, thereby raising questions about other human health effects (Felsot 1994, MacMahon 1994, Safe 1995). These effects were seen at concentrations measured in parts per trillion, levels at which most chemicals have never been tested. Other than the product-intended oral or dermal uses, exposure routes, after transmission to an OWTS, include ingestion of contaminated drinking water or foodstuffs, bathing or swimming in contaminated water, and possible respiratory contact.

Although some of the contaminants identified in Section 303(d) as contributing to impairment of water bodies in California are categorized as EDCs (as identified in Table 4.1-1), EDCs as a category are not currently regulated as water quality contaminants in federal or state water quality objectives. Typical wastewater pollutants of concern that are classified as EDCs include arsenic, cadmium, lead, mercury, dioxin, and dioxin compounds.

Although EPA is currently studying the transmission pathways and effects of EDCs and some scientific studies have investigated their effects on human health, these compounds are not currently regulated or classified as contaminants or pollutants by any federal, state, or local public health agency. Table 4.1-5 provides information on some EDCs and their relative estrogenic potencies. If additional information becomes available indicating that EDCs pose a risk to human health and/or the environment, this issue may merit consideration by public health agencies and the State Water Board.

## 4.1.3 ENVIRONMENTAL SETTING

The hydrologic cycle connects atmospheric water, surface water, and groundwater (Exhibit 4.1-2). Precipitation occurs as rain or snow and is deposited on the ground surface, where it either flows across the ground surface as runoff and eventually enters a surface water body or infiltrates the soil surface and eventually becomes groundwater. Groundwater then flows downgradient to meet up with surface water bodies, usually below the ground surface. Water in surface water bodies evaporates back into the atmosphere; water in soil is absorbed by plant roots and re-enters the atmosphere through the combined processes of evaporation and transpiration.




Source: Data provided by EDAW in 2007

**Hydrologic Cycle** **Exhibit 4.1-2**

**Table 4.1-5**
**EDC Compound Characteristics**

| | | CAS # | Molecular Weight | Log P Octonal/ Water Partition Coefficient (Kow) [1] | Water Solubility (mg/L) | Vapor Pressure (mm Hg-measured) | Henry's Law Constant (atm m3/mol) | Log Soil Adsorption Constant (Koc) [1] | Bioconcentration Factor | Potency (relative to 17-beta Estradiol) | Potency References |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Estrogens** | Estrone (E1) | 53-16-7 | 270 | 3.13 | 30 | 1.42E-07 | 3.80E-01 | | | 0.5 [2] | Metcalfe, et al. 2001 |
| | Estradiol (E2) | 50-28-2 | 272 | 4.01 | 3.6 | | 3.64E-11 | | | 1 | |
| | Ethinylestradiol (EE2) | 57-63-6 | 296 | 3.67 | 11.3 | 2.67E-09 | 7.94E-12 | | | 133.333 [2] | Metcalfe, et al. 2001 |
| **Surfactants/ Alkylphenolics** | Nonylphenol | 25154-52-3 | 220 | 3.8–6.36 [5] | 5,000 | 9.42E-05 | 2.40E-09 | 4.84 | 100.00 | 0.000089 [3] | Metcalfe, et al. 2001 |
| | 4-Nonylphenol (NP) | 104-40-5 | 220 | 5.76 | 7 | 8.18E-04 | 3.40E-05 | 4.48 | 88–984 | 0.000009 | Pait, et al. 2002 |
| | 4-Nonylphenol monoethoxylate (NP1EO) | | | 4.2 [6] | | | | 5–6.46 [7] | | 0.000002 [2] | Metcalfe, et al. 2001 |
| | 4-Nonylphenol diethoxylate (NP2EO) | | | 4.2 [6] | | | | 6–6.46 [7] | | 0.0000023 [2] | Metcalfe, et al. 2001 |
| | 4-Nonylphenol Diphenyl Phosphate | 64532-97-4 | 452 | 4.93 | 0.77 | 1.90E-08 | 1.40E-08 | 4.06 | 69.00 | na | |
| | Octylphenol (OP) | 27193-28-8 | 206 | | | | | | | 0.00001–0.0001 | Wenzel, et al. 2003 |
| | 4-Octylphenol monoethoxylate (OP1EO) | | | | | | | | | | |
| | 4-Octylphenol diethoxylate (OP2EO) | | | | | | | | | | |
| **Resin Plastics** | Bisphenol A (BPA) | 80-05-7 | 228 | 3.32 | 120 | 0.2 | 1.00E-11 | 2.47 | 2.7–7.4 | 0.0006780 [2] | Metcalfe, et al. 2001 |
| **Plastic Additives** | Benzyl butyl phthalate (BBP) | 85-68-7 | 312 | 4.73 | 2.69 | 8.25E-06 | 1.26E-06 | 4.23 | 16.78 | 0.00004–0.000001 | METI 2002; Harris, et al. 1997 |
| | bis(2-ethylhexyl) phthalate (DEHP) | 117-81-7 | 391 | 5.11 | 0.34 | 9.78E-08 | 1.02E-07 | 4.94 | 18.73 | 0.0000008 [2, 4] | Metcalfe, et al. 2001 |
| | diethyl phthalate (DEP) | 84-66-2 | 222 | 2.47 | 1,080 | 1.65E-03 | 4.50E-07 | 1.99 | 7.92 | 0.0000005 | METI 2002 |
| | dimethyl phthalate (DMP) | 131-11-3 | 194 | 1.56 | 4,000 | 1.65E-03 | 1.05E-07 | 1.60 | 5.81 | na | |
| | di-n-butyl phthalate (DBP) | 84-74-2 | 278 | 4.72 | 11.2 | 7.30E-05 | 1.81E-06 | 3.80 | 2.92 | 0.0000001–0.00003 | METI 2002; Ohtani, et al. 2000; Harris, et al. 1997 |
| | di-n-octyl phthalate (DNOP) | 117-84-0 | 391 | 8.1 | 0.02 | 2.60E-06 | 6.68E-05 | 3.38 | 42.10 | na | |
| **Pesticides/Herbicides/ Biocides** | Chloroform (Trichloromethane) | 67-66-3 | 119 | 1.97 | 7,920 | 197.3 | 3.67E-03 | 1.60 | 2.51 | na | |
| | gamma-BHC (Lindane) | 58-89-9 | 291 | 3.61 | 7.3 | 0.0041 | 1.40E-05 | 3.03 | 22.20 | 0.0000056 | Kojima 2004 |
| | Heptachlor | 76-44-8 | 373 | 4.27 | 0.18 | 0.0004 | 1.48 | 3.54 | 53.52 | 0.0000077 | Kojima 2004 |
| | Chlorpyrifos | 2921-88-2 | 251 | 4.96 | 1.12 | 2.03E-05 | 2.93E-06 | 3.78 | | | |

1 The pH was not specified in the calculation of these values.
2 Potency relative to E2 in medaka.
3 Yeast estrogenicity screening (YES) assay
4 Non-responsive, conservative estimate
5 EPA. 2003. Ambient Aquatic Life Water Quality Criteria for Nonylphenol - Draft
6 Sayles, et al. 2001. Biological Fate of Estrogenic Compounds Associated with Sewage Treatment: A Review
7 Brewer, et al. 1998. Survey Of Contaminants In Fraser River Suspended Sediment And Water Upstream And Downstream of Annacis Island Wastewater Treatment Plant

Potency References:

Kojima, et. al. 2004. Screening for Estrogen and Androgen Receptor Activities in 200 pesticides by In Vitro Reporter Gene Assays using Chinese Hamster Ovary Cells. Environmental Health Perspectives. April 2004.
Metcalfe, C. D., et al. 2001. Estrogenic Potency of Chemicals Detected in Sewage Treatment Plant Effluents as Determined by In Vivo Assays with Japanese Medaka (Oryzias latipes). Environmental Toxicology and Chemistry 20(2): 297-308.
METI. 2002. Hazard Assessment of Benzyl Butyl Pthalate. Japanese Ministry of Economy, Trade, and Industry. Available online: http://www.meti.go.jp/english/report/downloadfiles/gED0309e.pdf Accessed August 30, 2007.
Pait, A. S., and J. O. Nelson. 2002. Endocrine Disruption in Fish: An Assessment of Recent Research and Results. NOAA Tech. Memo. NOS NCCOS CCMA 149. NOAA, NOS, Center for Coastal Monitoring and Assessment 55 pp. Silver Spring, MD.
Wenzel, A., J. Miller, and T. Ternes. 2003. Study of endocrine disrupters in drinking water. Fraunhofer Institute for Molecular Biology and Applied Ecology (IME). Schmallenberg, Germany.

Sources, unless otherwise noted (except potency): Syracuse Research Corporation (2004), ChemFinder (2004)

Groundwater can also be pumped through wells into municipal water supply systems or homes, and from there into OWTS and back into groundwater. (See “Groundwater, Surface Water, Water Supply, and OWTS” below for more information.)

A brief overview of the hydrologic regions of California is provided below (for more information refer to Appendix F). This section briefly summarizes the general water quality characteristics of the hydrologic regions and the Regional Water Boards’ water quality objectives for each region. More thorough descriptions are provided in Appendix F. This overview is intended to provide a sense of the wide variety of hydrologic conditions throughout California that affect the availability of groundwater and surface water, soil conditions, and the resultant operation of OWTS in those diverse regions.

OWTS can affect the hydrologic cycle because they disperse treated domestic wastewater into the unsaturated zone of the soil, allowing the treated effluent to return to groundwater. As a result, OWTS have the potential to affect surface water and groundwater through the series of mechanisms described after the overview of the hydrologic regions and groundwater aquifers.

Information has been obtained from the Regional Water Boards’ basin plans, DWR Bulletin 118, DWR 2005, and other sources where noted. Areas listed under Section 303(d) as impaired water bodies (and thus for which TMDLs have been, are being, or must be prepared) are identified in Tables 2-2, 2-3, and 2-4, and these areas are shown in Exhibits 3-1a through 3-1f. (In addition, Appendix E provides more detailed maps of those areas listed as impaired under Section 303[d].) Exhibit 4.1-1 shows the location of the OWTS discharge prohibition areas established by each Regional Water Board.

### HYDROLOGIC REGIONS OF CALIFORNIA

Hydrologists divide California into 10 hydrologic regions (CalWater 1999) (Exhibit 4.1-3). The Regional Water Boards are defined (for the most part) by the boundaries of these hydrologic regions, as described in Water Code Section 13200; those boundaries are shown in Exhibit 2-4. Because of their connection to individual Regional Water Boards, the basin plans and 303(d) contaminant lists also correlate to these hydrologic regions. The hydrologic regions are divided into hydrologic units, hydrologic areas, and hydrologic subareas.

Water quality is monitored through the state programs described in 4.1.1, “Regulatory Setting,” above. Primary water quality issues vary around the state depending on:

- the location and type of water resources present in an area,
- the size and extent of the watershed and regional water resources,
- the location of the water body with respect to potential pollutant sources,
- seasonal and climatic factors, and
- many other interacting physical, chemical, and biological processes.

Medium to large bodies of surface water typically have a large capacity for assimilating pollutant loads because their various physical and chemical processes effectively dilute pollutants or transform them into less harmful chemical constituents. Biological processes are especially important because many chemicals can be absorbed by plants or animals and are thereby removed from the water, or are metabolized in biological tissues and become less harmful substances. Consequently, water quality impairment at a large scale is often associated with watersheds in which there have been large-scale changes to the natural habitat (e.g., agricultural activities, urban development) and that receive pollutants from a variety of sources.

Typical OWTS wastewater contaminants of concern are found in Table 2-5. In general, the beneficial uses of large water bodies such as lakes and reservoirs typically become impaired by noxious weeds, trace metals, pesticides, and taste and odor problems. Smaller surface waters such as rivers and streams may be affected by a much larger variety of pollutants, including sediments, pathogens, pesticides, trace metals, and legacy


Source: DWR 2003

**Hydrologic Regions and Groundwater Basins in California** **Exhibit 4.1-3**

contaminants (pollutants that have been banned or replaced and are no longer supplied to the environment in large quantities, but that remain in the environment for an extended period after deposition with little degradation) such as dichlorodiphenyltrichloroethane (DDT) and PCBs. Freshwater wetlands may be affected primarily by trace metals, salinity, and other trace elements. Common stressors found in coastal and estuarine systems that can be caused by OWTS include elevated nutrient concentrations (N and phosphorus), which can result in prolonged phytoplankton blooms, low dissolved oxygen, and sedimentation (EPA 2000).

### North Coast Hydrologic Region

The North Coast hydrologic region covers approximately 12.46 million acres (19,470 square miles) and encompasses Siskiyou, Del Norte, Trinity, Humboldt, Mendocino, Sonoma, and small areas of Marin Counties. The region extends from the Oregon border south to Tomales Bay and includes portions of the northern Coast Range, the Mad River drainage, the Klamath Mountains, and the coastal mountains. The majority of the population is located along the Pacific Coast and in the inland valleys north of the San Francisco Bay Area. The northern mountainous portion of the region is rural and sparsely populated, and most of the area is heavily forested. Average annual precipitation in this hydrologic region ranges from 100 inches in the Smith River drainage to 29 inches in the Santa Rosa area.

Groundwater aquifers in the northeastern portion of the North Coast hydrologic region consist primarily of volcanic rock aquifers and some basin-fill aquifers. Coastal basin aquifers are predominantly found in the southern portion of this hydrologic region and along the northern coast (Exhibit 4.1-4). In general, though, a large percentage of this region is underlain by fractured hard rock zones that may contain localized sources of groundwater. See “Groundwater Aquifers in California” below for descriptions of these various aquifer types.

Two Septic Tank Discharge Prohibition Areas (established by the Regional Water Board in 1988) are in the North Coast region, both in the southern portion of the region in Sonoma County (State Water Board 2007).

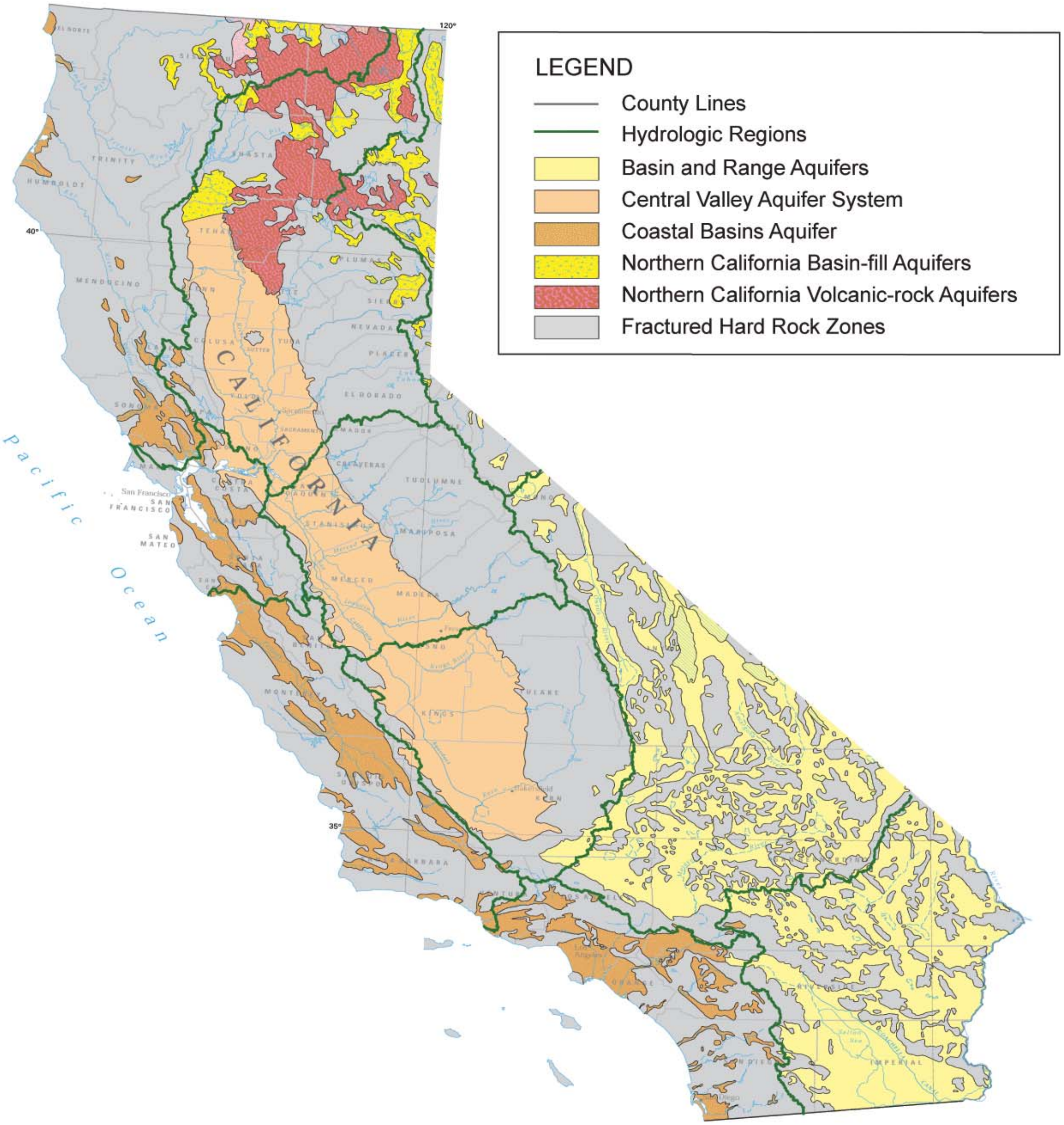
### San Francisco Bay Hydrologic Region

The San Francisco Bay hydrologic region covers approximately 2.88 million acres (4,500 square miles) and encompasses San Francisco and portions of Marin, Sonoma, Napa, Solano, San Mateo, Santa Clara, Contra Costa, and Alameda Counties. The San Francisco Bay hydrologic region is dominated by the Coast Range. Significant geographic features include the Marin and San Francisco peninsulas; San Francisco, Suisun, and San Pablo bays; and the Santa Cruz Mountains, Diablo Range, Bolinas Ridge, and Vaca Mountains of the Coast Range. Although this is the smallest hydrologic region in the state, it contains the second largest human population.

Coastal basin aquifers are the primary type of aquifer system in this region. They can be found along the perimeter of San Francisco Bay extending southeast into the Santa Clara Valley, as well as in the Livermore Valley. The northeastern portion of this region, which includes the eastern Sacramento–San Joaquin Delta, is underlain by a portion of the Central Valley aquifer system. The remaining areas in this region are underlain by fractured hard rock zones. There are four OWTS Discharge Prohibition Areas in this region (State Water Board 2007). However, elevated levels of nitrate have been detected in a large percentage of private wells tested within subbasins located south of the Santa Clara Valley. Persistent nitrate contamination has also been shown in the shallow aquifer zone within the Petaluma Valley.

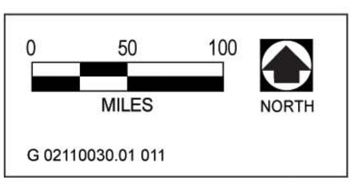
### Central Coast Hydrologic Region

The Central Coast hydrologic region covers approximately 7.22 million acres (11,300 square miles) in central California and includes all of Santa Cruz, Monterey, San Luis Obispo, and Santa Barbara Counties, most of San Benito County, and parts of San Mateo, Santa Clara, and Ventura Counties. Groundwater is the primary source of water in the region, accounting for approximately 75% of the annual supply. Most of the freshwater in this region




Base modified from U.S. Geological Survey digital data, 1:2,000,000, 1972 Albers Equal-Area Conic projection Standard parallels 29°30' and 45°30', central meridian -96°00'

Modified from California Department of Water Resources, 1980; Plume and Carlton, 1988; U.S. Geological Survey, 1984; and J.R. Harrill, U.S. Geological Survey, written commun., 1991




California Department of Water Resources, 1980, Ground water basins in California: California Department of Water Resources Bulletin 118–80, 73 p.
Dunbar, C.O., 1966, Historical geology: New York, John Wiley and Sons, Inc., 500 p.
Plume, R.W., and Carlton, S.M., 1988, Hydrogeology of the Great Basin region of Nevada, Utah, and adjacent States: U.S. Geological Survey Hydrologic Investigations Atlas HA–694–A.
U.S. Geological Survey, 1984, National water summary 1983—Hydrologic events and issues: U.S. Geological Survey Water-Supply Paper 2250, 243 p.

Source: DWR 1980, as modified by EDAW

**California Groundwater Aquifers Systems** **Exhibit 4.1-4**

is found in coastal basin aquifers, with localized sources of groundwater also occurring in fractured hard rock zones throughout the region (Exhibit 4.1-4). Two OWTS Discharge Prohibition Areas have been established in this region (State Water Board 2007).

## South Coast Hydrologic Region

The South Coast hydrologic region includes all of Orange County; most of San Diego and Los Angeles Counties; parts of Riverside, San Bernardino, and Ventura Counties; and a small portion of Kern and Santa Barbara Counties. Because it is the most populous area of the state, it is divided among three Regional Water Boards. Approximately half of California's population, or about 17 million people, live within the boundaries of the South Coast hydrologic region. This, combined with its comparatively small surface area of approximately 6.78 million acres (10,600 square miles) gives it the highest population density of any hydrologic region in California. Major population centers include the metropolitan areas surrounding Ventura, Los Angeles, San Diego, Orange County, San Bernardino, and Riverside.

Groundwater is what supplies approximately 23% of the region's water in normal years and about 29% in drought years. Like the Central Coast hydrologic region, the majority of aquifers in this region are coastal basin aquifers. In the eastern central portion of the region includes lies a small section of basin and range aquifer and the remainder of the region is comprises fractured hard rock zones. There are eight OWTS Discharge Prohibition Areas in the South Coast Hydrologic Region (State Water Board 2007).

## Central Valley Hydrologic Region

The Central Valley hydrologic region is the largest in California, and encompasses the three subregions described below. There are a total of 30 OWTS Discharge Prohibition Areas in the Central Valley Hydrologic Region (State Water Board 2007).

### *Sacramento River Hydrologic Subregion*

The Sacramento River hydrologic subregion, which corresponds to approximately the northern third of the Central Valley Regional Water Board, covers 27,246 square miles and includes all or a portion of 20 predominantly rural northern California counties. The region extends from the crest of the Sierra Nevada in the east to the summit of the Coast Range in the west, and from the Oregon border north downstream to the Sacramento–San Joaquin Delta. It includes the entire drainage area of the Sacramento River, the largest river in California, and its tributaries.

Groundwater in the northern half of this hydrologic subregion is, for the most part, contained in volcanic rock aquifers and some basin-fill aquifers. The southwestern half of this subregion is underlain by part of the Central Valley aquifer system. The remaining areas that comprise the southeastern half of the subregion and portions of the northern half of the subregion are underlain by fractured hard rock zones. (Exhibit 4.1-4) Surface water quality in this hydrologic subregion is generally good. Groundwater quality in the Sacramento River subregion is also generally good, although there are localized problems.

### *San Joaquin River Hydrologic Subregion*

The San Joaquin River hydrologic subregion is bordered on the east by the Sierra Nevada and on the west by the coastal mountains of the Diablo Range. It extends from the southern boundaries of the Sacramento–San Joaquin Delta to the northern edge of the San Joaquin River in Madera. It consists of the drainage area of the San Joaquin River, which at approximately 300 miles long is one of California's longest rivers, and also encompasses approximately half of the Sacramento–San Joaquin Delta. The San Joaquin River hydrologic region covers approximately 9.7 million acres (15,200 square miles). A portion of the Central Valley aquifer system underlies nearly all of the eastern half of this subregion, while the western half of this subregion consists of fractured hard rock zones. The groundwater quality throughout this hydrologic region is generally good and usable for most urban and agricultural uses, although localized problems occur.

### Tulare Lake Hydrologic Subregion

The Tulare Lake hydrologic subregion is located in the southern end of the San Joaquin Valley and includes all of Tulare and Kings Counties and most of Fresno and Kern Counties. Major cities include Fresno, Bakersfield, and Visalia. The region covers approximately 10.9 million acres (17,000 square miles). A small area at the southern end of this region in underlain by basin and range aquifers, while a majority of the western half is underlain by a portion of the Central Valley aquifer system The eastern half, once again, consists of fractured hard rock zones.

### Lahontan Hydrologic Region

The Lahontan hydrologic region encompasses the North and South Lahontan subregions. There are 14 OWTS Discharge Prohibition Areas in the Lahontan Hydrologic Region (State Water Board 2007).

#### *North Lahontan Hydrologic Subregion*

The North Lahontan hydrologic subregion extends south from the Oregon border approximately 270 miles to the South Lahontan region. Extending east to the Nevada border, it consists of the western edge of the Great Basin, and water in the region drains eastward toward Nevada. Groundwater in the northern half of this subregion is primarily contained in basin-fill and volcanic rock aquifers, with some fractured hard rock zones. The southern half of this region is dominated by fractured hard rock zones, but small segments of basin and range aquifers also exist in this part of the subregion. The subregion, corresponding to approximately the northern half of the Lahontan Regional Water Board, covers approximately 3.91 million acres (6,110 square miles) and includes portions of Modoc, Lassen, Sierra, Nevada, Placer, El Dorado, Alpine, Mono, and Tuolumne Counties.

In general, the water quality in the North Lahontan hydrologic region is good. In basins in the northern portion of the region, groundwater quality is widely variable. The groundwater quality along these basin margins tends to be of higher quality, but the potential for future groundwater pollution exists in urban and suburban areas where single-family septic systems have been installed, especially in hard rock areas. Groundwater quality in the alpine basins ranges from good to excellent.

#### *South Lahontan Hydrologic Subregion*

The South Lahontan hydrologic subregion in eastern California, which includes approximately 21% of the state, covers approximately 21.2 million acres (33,100 square miles). This region contains both the highest (Mount Whitney) and lowest (Death Valley) surface elevations of the contiguous United States. It is bounded on the west by the crest of the Sierra Nevada and on the north by the watershed divide between Mono Lake and East Walker River drainages; on the east by Nevada and the south by the crest of the San Gabriel and San Bernardino mountains and the divide between watersheds draining south toward the Colorado River and those draining northward. The subregion includes all of Inyo County and parts of Mono, San Bernardino, Kern, and Los Angeles Counties.

This subregion contains numerous basin and range aquifers, separated by fractured hard rock zones. Although the quantity of surface water is limited in the South Lahontan hydrologic subregion, the quality is very good, being greatly influenced by snowmelt from the eastern Sierra Nevada. However at lower elevations, groundwater and surface water quality can be degraded, both naturally from geothermal activity, and as a result of human-induced activities. Drinking water standards are most often exceeded for TDS, fluoride, and boron content.

Groundwater near the edges of valleys generally contains lower TDS content than water beneath the central part of the valleys or near dry lakes.

### Colorado River Hydrologic Region

The southeast portion of California comprises the Colorado River hydrologic region, which contains 12% of the state's land area. The Colorado River forms most of the region's eastern boundary except for a portion of Nevada at the northeast, and extends south to the Mexican border. The region includes all of Imperial County, approximately the eastern one-fourth of San Diego County, the eastern two-thirds of Riverside County, and the southeastern one-third of San Bernardino County. It includes a large portion of the Mojave Desert and has variable, arid desert terrain that includes many bowl-shaped valleys, broad alluvial fans, sandy washes, and hills and mountains. Aquifers in this region are nearly all of the basin and range type. To date, two OWTS Discharge Prohibition Areas have been established and both are in the central western portion of the region (State Water Board 2007).

## GROUNDWATER

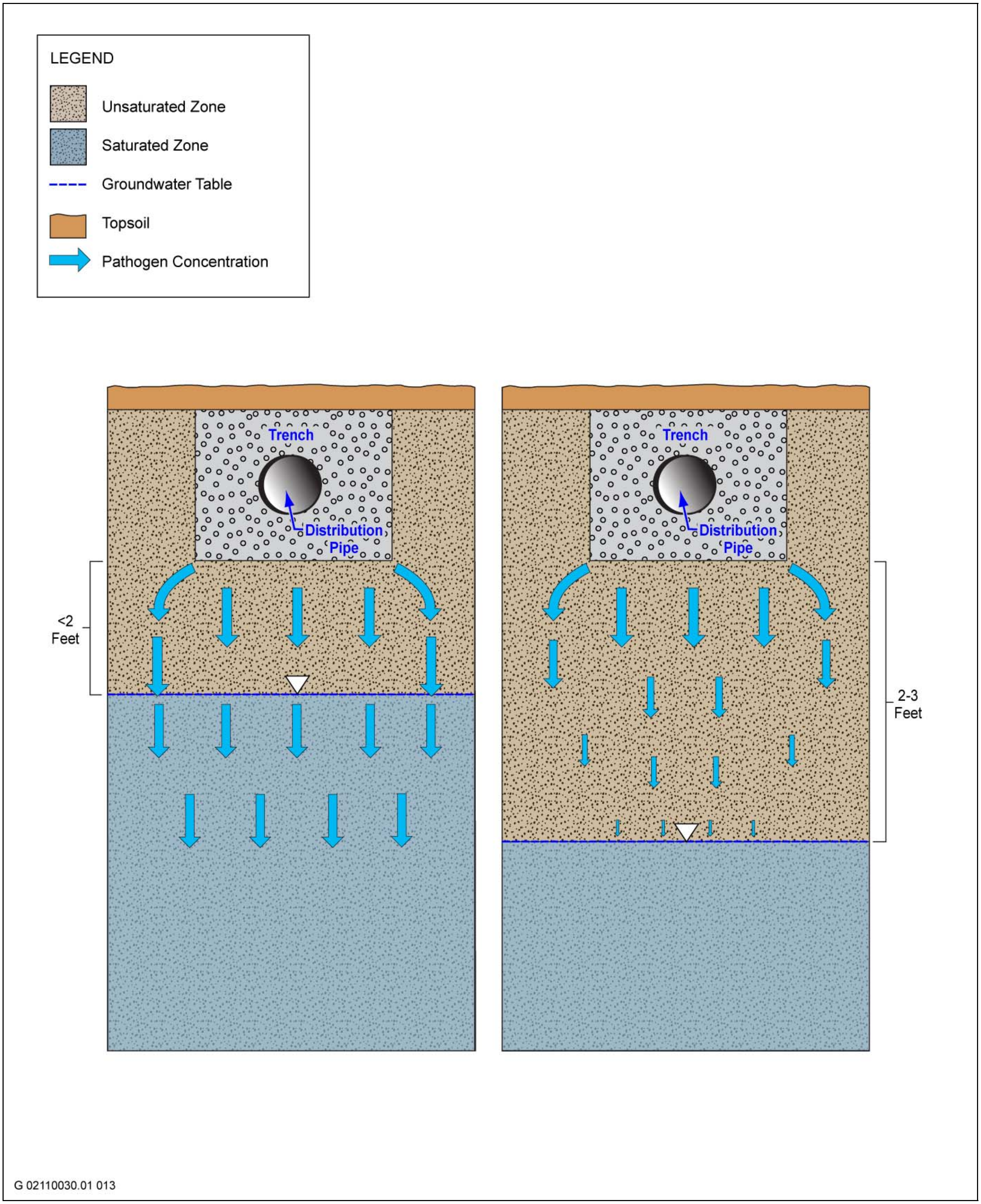
Groundwater is water located beneath the ground surface in soil pore spaces and in the fractures of geologic formations. Groundwater is the largest single source of freshwater available for human use—domestic use, drinking water, agriculture, and industrial uses (USGS 1999). Since 1987, 82% of water supply wells in California that were newly constructed, reconditioned, or deepened, were drilled for individual domestic uses (DWR 1998).

The primary concern with OWTS is partially caused by acute effects from untreated wastewater surfacing and running off into surface waters or from polluting groundwater after receiving zero or only partial treatment of pathogens, resulting in impacts on public health. Additional concern is nitrate and other contaminants entering groundwater because groundwater will move those contaminants in a concentrated plume. To address this, the primary objective in regulating the siting, construction, and operation of OWTS is the relationship between the treatment system and the groundwater aquifer underlying it. Local regulations typically focus on ensuring that effluent entering the dispersal field has (1) an adequate depth (often defined as 3–5 feet) of unsaturated soil before reaching groundwater and (2) appropriate soil type, as measured by the percolation rate of clean water being absorbed into the soil or other standard soil evaluation methods. Meeting these two requirements is believed to provide sufficient residence time for pathogens to die off in the soil. The soil behaves as an additional treatment mechanism, removing some additional amounts of contaminants that were not removed by the OWTS pretreatment system (e.g., septic tank).

Exhibits 4.1-5, 4.1-6, and 4.1-7 depict a range of representative soil and groundwater conditions that must be considered in the siting and design of OWTS to ensure effective operation and performance. These conditions include depth to the groundwater table (Exhibit 4.1-5), soil type (Exhibit 4.1-6), potential to affect nearby domestic wells in confined (condition A in Exhibit 4.1-7) and unconfined (condition B in Exhibit 4.1-7) aquifer situations (detailed below), potential to affect surface water (condition C in Exhibit 4.1-7), and OWTS in a fractured rock environment (condition D in Exhibit 4.1-7). The discussion below provides additional explanation of the interaction between groundwater and OWTS operation.

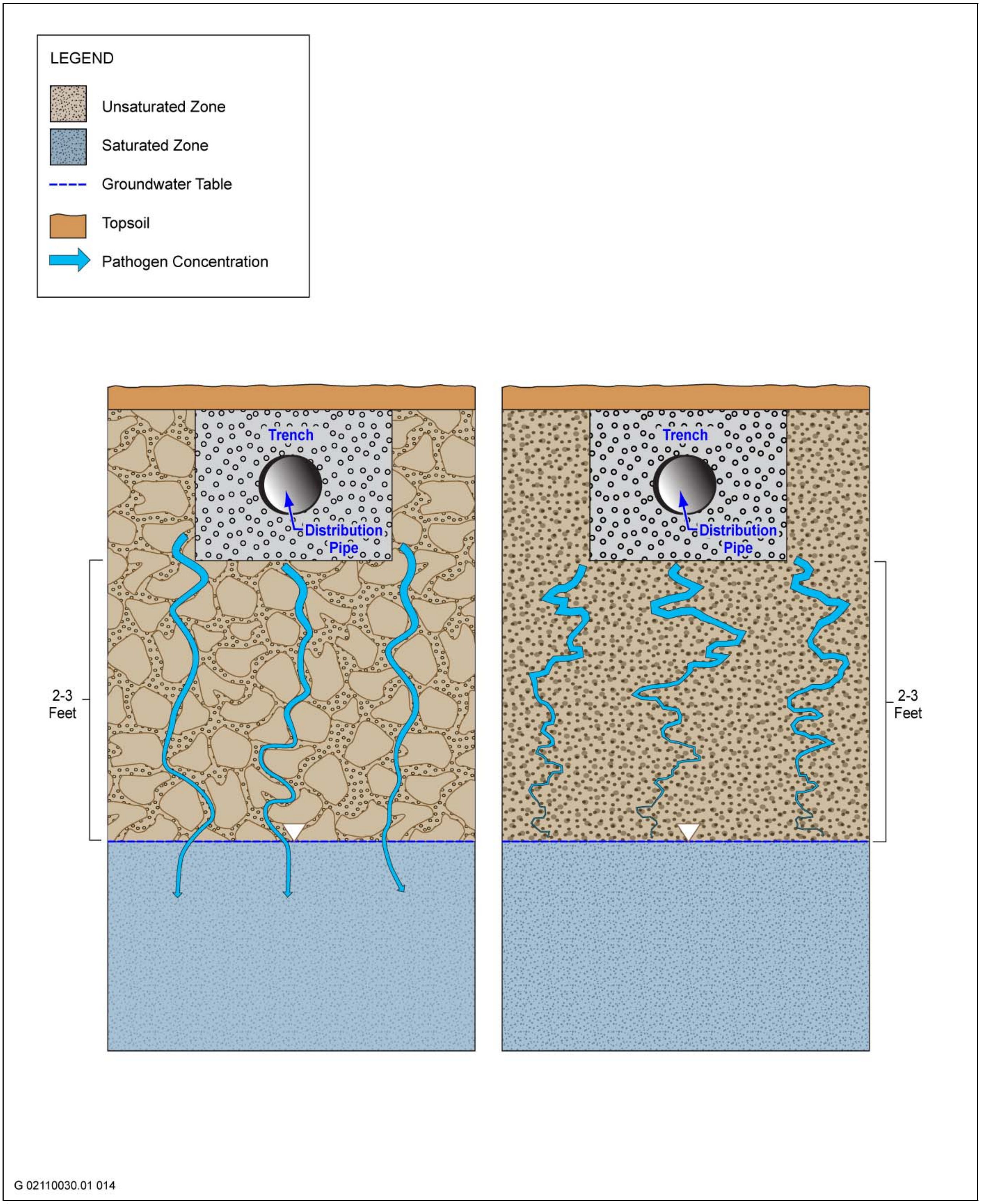
### Groundwater Conditions

As described briefly above and in more detail below, the depth of unsaturated soil between the dispersal field and the groundwater table is a key determinant of the effectiveness of pathogen removal before effluent reaches groundwater (Exhibit 4.1-5). The degree of confinement of groundwater at a given location is another important factor that determines the risk of treated effluent coming into contact with groundwater. The most common groundwater conditions are described below.




Source: Data provided by EDAW in 2008

**Depth to Groundwater Table** **Exhibit 4.1-5**




Source: Data provided by EDAW in 2008

**Soil Texture and OWTS Function** **Exhibit 4.1-6**

The uppermost portion of the earth's crust can be divided into the unsaturated zone and the saturated zone (Exhibits 4.1-5 and 4.1-7). The unsaturated zone is where available spaces between soil pores are filled with air, other gases, and some water and where the water that is present adheres to the surfaces of the sediment grains and cannot be easily extracted (Bachman et al. 2005). Farther down is the saturated zone where all available spaces are filled with water (e.g., aquifers). This is where available "groundwater" lies.

### *Unconfined versus Confined Groundwater*

Aquifers are typically saturated zones (soils fully inundated by water) that provide an economically feasible quantity of water to a well or spring. The two ends of the spectrum of aquifer types are confined and unconfined (conditions A and B in Exhibit 4.1-7). Unconfined aquifers are sometimes also called water table aquifers because their upper boundary is the water table. Typically (but not always) the shallowest aquifer at a given location is unconfined, meaning it does not have an impermeable confining layer acting as a lid (an aquitard or an aquiclude, an aquitard with extremely low permeability) between it and the surface. Unconfined aquifers usually recharge (i.e., receive water to replace the water that is removed or flows out) either directly from the ground surface as runoff held by lakes, creeks, and streams that infiltrates into the aquifer or through precipitation that infiltrates directly through the soil.

In an unconfined aquifer, water that infiltrates directly from the surface can transport contaminants with it. Concentrations of some contaminants may be reduced by the soil to some extent depending on how porous the soil is and the nature of the contaminant. Where the soil is sandy or porous, water flows more quickly below the surface and fewer contaminants are removed before reaching groundwater.

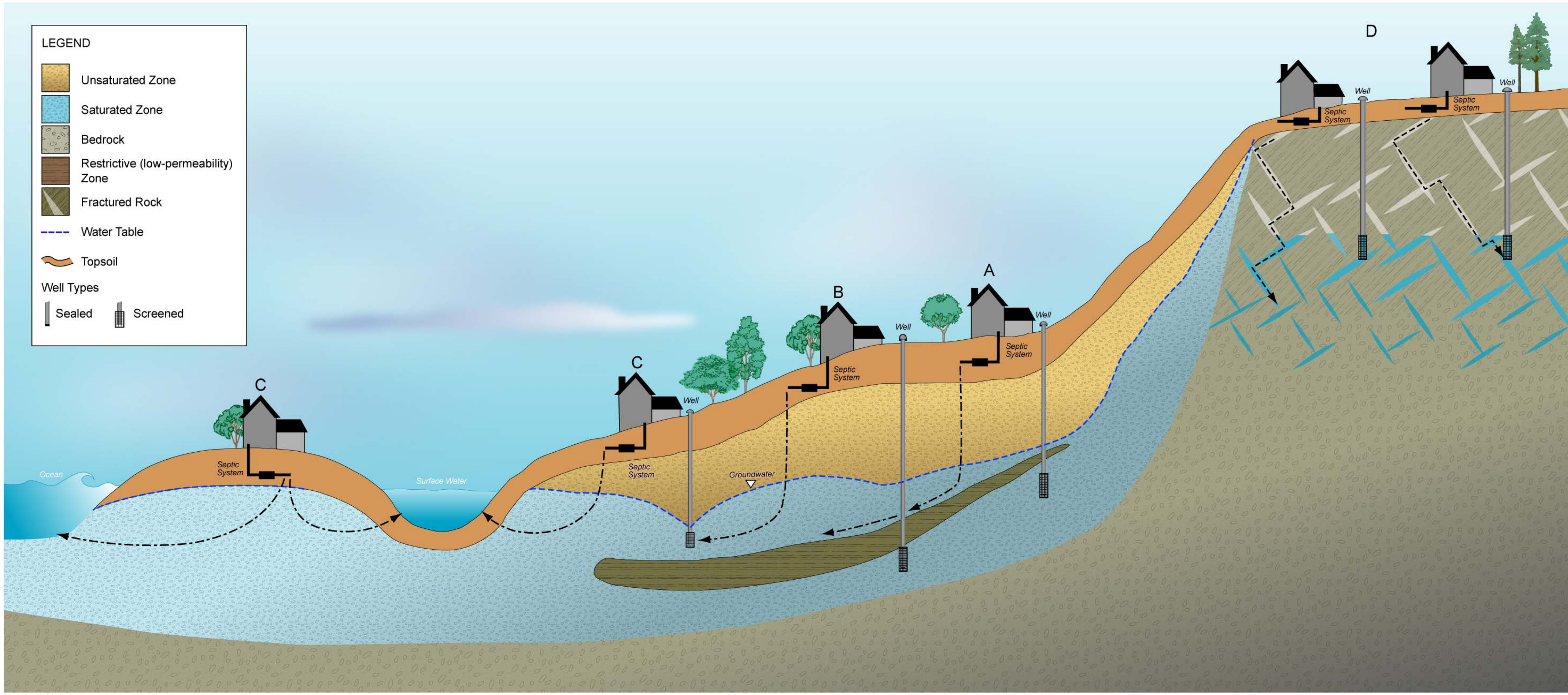
Confined aquifers are typically found below unconfined aquifers, separated by an aquitard or aquiclude (barrier). Under natural conditions in a confined aquifer, the layers of minimally permeable or impermeable clay or rock above and below the aquifer protect the water from contact with some surface contaminants and somewhat restrict the water's movement. The recharge area for a confined aquifer, where surface water (and associated contaminants) infiltrates the land and resupplies the aquifer, may be miles from a well that draws water from it. Wells, however, can cause cross contamination by short-circuiting the natural flow pathway and by introducing surface contaminants into deeper groundwater.

The term "perched" refers to groundwater accumulating above a low-permeability unit or strata, such as a clay layer. This term is generally used to refer to a small local area of groundwater that collects at an elevation higher than a regionally extensive aquifer. The difference between perched and unconfined aquifers is their size; a perched aquifer is smaller and more locally contained whereas an unconfined aquifer more broadly underlies a larger area.

### *Unconsolidated Alluvium versus Fractured Hard Rock*

In nonmountainous areas (or near rivers in mountainous areas), the main aquifers are typically unconsolidated alluvium—loose gravel, sand, and silt with pore spaces between the grains. These aquifers are typically composed of mostly horizontal layers of materials deposited by water processes (rivers and streams), which in cross-section appear to be layers of alternating coarse and fine materials (conditions A and B in Exhibit 4.1-7). Coarser soil materials, because of the high energy needed to move them, tend to be found nearer their source (mountain fronts or rivers), while fine-grained soil material can travel farther from the source (to the flatter parts of the basin or overbank areas). Because coarse soils are located closer to the source, aquifers in these areas are often unconfined or may break through to the land surface (usually in springs or riverbeds).

In mountainous and hilly areas, the main water-bearing features are typically fractured hard rock formations (condition D in Exhibit 4.1-7). A thin layer of sediments, soil, or weathered rock frequently covers the hard rock formations. Cracks or fractures typically form in hard rock and are the result of different types of stress on the rock (i.e., folding, fault movement, weathering, heating, cooling). Fractures may be large or small and may run vertically or horizontally. They may be a few millimeters to hundreds of meters long and range in width from less




Source: Data provided by EDAW in 2008

**Representative Conditions for OWTS Discharges** **Exhibit 4.1-7**

than a millimeter to several centimeters. In carbonate rocks (limestone and dolomite) the fractures may be enlarged into caverns when the rock is dissolved by water. Most fractures are found in the upper few hundred feet of rock, although deep fractures are common. The width of fractures tends to diminish with depth.

Groundwater can percolate through the thin layer of soil and enter cracks or fractures of hard rocks, such as granite, greenstone, and basalt (Exhibit 4.1-6, condition D in Exhibit 4.1-7). The water does not actually penetrate the rocks because no pore space is present between the grains of the rock. However, some of these rocks have fractures in them that can store and transmit water over large distances and yield water to wells. The amount of groundwater that may be yielded to wells that intersect the fractures depends on the size and location of the fractures, the interconnection of the fractures, and the amount of collected soil material that may fill the fractures. Water can also be stored in lava tubes in volcanic rock and in solution openings in carbonate rocks. Some sedimentary rocks, like sandstone, are hard but can still absorb some water into their pores. These rocks may also have fractures that contain water.

### Groundwater Aquifers in California

California has five major aquifers or aquifer systems (Exhibit 4.1-4) and large areas that do not represent principal aquifers but that may contain locally important groundwater sources (Exhibit 4.1-4, areas in gray) (Planert and Williams 1995). Although four of the aquifers consist of basin-fill deposits (unconsolidated or semiconsolidated alluvium), the characteristics of these deposits vary, depending on differences in geology, physiography, and climate. Below is a general description of each of the major aquifers in California.

#### *Basin and Range Aquifers*

The basin and range aquifers in California contain two principal aquifer types: basin-fill aquifers and carbonate-rock aquifers. These aquifers underlie parts of eastern and southern California, including the White and Inyo Mountains, the Owens Valley, Mono Lake, Death Valley, and the Mojave and Colorado Desert regions. The most permeable basin-fill deposits are present in depressions created by block faulting and originate from alluvial-fan, lake-bed, or fluvial (river-formed) deposits. The carbonate-rock aquifers underlie alluvial basins and occur in carbonate rock that is highly fractured and locally brecciated (i.e., contains angular fragments of older rocks cemented together).

#### *Central Valley Aquifer System*

The Sacramento and San Joaquin Valleys compose the Central Valley, which is a basin comprising thousands of feet of sedimentary deposits. The Central Valley aquifer system, which underlies the Central Valley, is the largest basin-fill aquifer system in California. It is a single heterogeneous aquifer system formed primarily of sand and gravel with large amounts of fine-grained materials, such as silt and clay, occurring in beds and lenses scattered vertically and horizontally throughout the system. Water in the upper few hundred feet of this aquifer system is typically unconfined. With increasing depth, the numerous overlapping lens-shaped clay beds result in increasing confinement of groundwater.

#### *Coastal Basin Aquifers*

The California coastal region is characterized by mountain ranges and intermontane valleys that formed as a result of folding, faulting of marine sediments, and associated vulcanism. The terrestrial, marine, and volcanic rocks deposited in the intermontane valleys compose the Coastal Basin aquifers. These aquifers consist of continental deposits of sand and gravel that, in some cases, are interbedded with confining units of fine-grained material, such as silt and clay. Natural movement of water in these aquifers is generally parallel to the long axis of the basin because of impermeable rocks that commonly form a barrier between the basin and the sea. However, in a few coastal basins the coastal barrier is absent and the natural direction of flow is perpendicular to the long axis of the basin, from the inland mountains to the sea.

### *Northern California Basin-Fill Aquifers*

The northern California basin-fill aquifers comprise an assemblage of intermontane valley aquifers in unconsolidated alluvium that have similar hydrogeologic characteristics. These valleys are located mostly in the Cascade Mountains, the northern Sierra Nevada, and the Modoc Plateau. Groundwater in these valleys is contained mostly in alluvial-fan and lake deposits that fill the basins and may be under unconfined or confined conditions depending on the depth and the amount of fine-grained materials present.

### *Northern California Volcanic-Rock Aquifers*

The northern California volcanic-rock aquifers are located in the Modoc Plateau and the Cascade Mountains in volcanic terranes. These aquifers are not distinct, identifiable aquifers because they contain water in fractures, volcanic pipes, tuff beds, rubble zones, and interbedded sand layers.

### *Fractured Hard Rock Zones*

The remaining areas in California are areas that lack sufficient basin-fill sediments or permeable consolidated rock. Although these areas do not represent principal aquifers, they frequently have localized sources of groundwater that may provide water to individual wells. One-quarter of all public supply wells are in these areas.

## INTERACTION BETWEEN OWTS DISCHARGES AND GROUND- AND SURFACE WATERS

OWTS operate by receiving wastewater from nearby buildings and providing a level of preliminary treatment. After preliminary treatment is completed, treatment is furthered in the soil column and through the vadose zone after discharge from the dispersal field. The effluent, and what pollutants remain, then enters the groundwater, where it typically moves as a plume with groundwater flow. Sometimes this affected groundwater makes its way to surface water bodies and contributes or causes surface water pollution. The transport of pollutants can occur even when an OWTS is optimally sited and designed and maximizes natural opportunities for pollutant reduction.

### OWTS Discharge Interaction with Groundwater

Groundwater normally moves slowly through the pore spaces between particles of unconsolidated earth materials or through networks of fractures and solution openings in consolidated rocks. A velocity of 1 foot per day or greater is a high rate of movement for groundwater, and groundwater velocities can be as low as 1 foot per year or, in some areas, 1 foot per decade. In contrast, velocities of streamflow generally are measured in feet per second. (A velocity of 1 foot per second is the equivalent of about 16 miles per day.) The low velocities of groundwater flow can have important implications, particularly in relation to the movement of contaminants (see “Infiltration Rate” below).

Under natural conditions, groundwater moves along flow paths from areas of recharge to areas of discharge at springs or along streams, lakes, and wetlands. Natural discharges also occur as seepage to bays or the ocean in coastal areas and through transpiration by plants whose roots extend to near the water table. The pumping of groundwater from wells provides artificial flow paths for groundwater discharge to the surface. Wells are used to pump groundwater for many purposes, including domestic and municipal drinking water supply, irrigation, and industrial uses.

Because septic systems recharge groundwater by discharging wastewater through a dispersal system, and nearby water supply wells pump groundwater, the potential exists for contaminants in septic system effluent that is discharged to reach water supply wells. (See Section 2.7.3, “Human Exposure to OWTS-Degraded Groundwater,” and Exhibit 2-3, “Example of OWTS Effluent Plume Movement,” for details on the movement of effluent plumes, as well as Exhibits 4.1-5, 4.1-6 and 4.1-7). Domestic wells usually are shallow, have short well seals for protection from contaminants, and the water is rarely treated. For this reason, the potential for OWTS to contaminate groundwater raises concerns regarding the safety of domestic water supply wells. OWTS are also considered a common source of contamination of public supply wells. However, public supply wells are typically deep and have long sanitary seals. In addition, public supply well water may be treated to meet drinking water standards and is required to be tested regularly. However, a domestic water supply that serves individual property owners is not regulated for water quality and is seldom tested.

Generally, a domestic well that is constructed in a confined aquifer (condition A in Exhibit 4.1-7) may be afforded some level of protection from OWTS effluent by the confining layer, unless the well creates a short circuit. However, a well constructed in an unconfined aquifer (condition B in Exhibit 4.1-7) may be affected by an OWTS discharging effluent upgradient from that well.

In a fractured rock environment (condition D in Exhibit 4.1-7), with no confining layers to protect the well, sanitary seals (which keep moisture from entering the well until the desired depth is reached) may not be as protective. Groundwater or effluent in fractured rock can travel rapidly over long distances with little natural treatment (because little soil is present to impede flow and treat effluent as shown in Exhibit 4.1-6), and the paths of the fractures are unpredictable (resulting in uncertainty about whether the well will intercept groundwater contaminated with inadequately treated effluent from another OWTS.

### Groundwater Interaction with Surface Water

Groundwater and surface water interact under all types of conditions (Winter et al. 1998). Groundwater can interact with streams, lakes, bays, estuaries, wetlands, and coastal areas (Exhibit 4.1-2). The interconnection between groundwater and surface water has important ramifications for water quality because water, chemical constituents, and microorganisms can be transferred between them, essentially affecting two types of water supply.

According to a national study performed by the U.S. Geologic Survey (USGS 1999), an average of 52% of streamflow throughout the United States is provided by groundwater. The groundwater contribution can vary tremendously depending on the season and watershed characteristics. It is important to note that the chemistry, flow, and quality of groundwater and surface water can directly affect one another.

The connection between groundwater and surface water is particularly important in areas where either of these is contaminated. Surface water bodies are designated as impaired under Section 303(d) of the Clean Water Act (Exhibits 3-1a through 3-1f) if contaminants are present that are known to impair any beneficial uses of those waters (described in Chapter 3.0, “Regulatory Setting,” and Section 4.1.1 above). Some contaminants that impair the beneficial use of groundwater or surface water can originate in OWTS. As described above, the most common contaminants in OWTS effluent are pathogens (primarily bacteria and viruses) and nutrients (primarily nitrogen in various chemical forms). These contaminants can travel from OWTS effluent into groundwater and from the groundwater aquifer into surface water bodies. As a result, OWTS near water bodies designated as impaired are a primary focus of concern with regard to public health, since they may be contributing additional contaminants to water bodies already being adversely affected by these contaminants. For some water bodies, OWTS are specifically identified in the Section 303(d) listing as contributing to the impairment. Regardless of whether OWTS are identified as a contributing source of contamination, they are a possible source that must be considered because of the interaction between OWTS effluent, groundwater, and surface water.

## FACTORS AFFECTING THE FATE AND TRANSPORT OF OWTS POLLUTANTS OF CONCERN

Conventional OWTS work best when they are designed and installed appropriately based on the geology, soils, and hydrology of the site and surrounding areas. As discussed below, the general location, topography, soil characteristics (e.g., permeability and texture), soil depth to bedrock and groundwater, and a wide variety of other geologic and soil-related factors must be considered in OWTS siting and design.

EPA's *Onsite Wastewater Treatment Systems Manual* (2002) notes that a properly designed, sited, constructed, and maintained conventional OWTS effectively reduces or eliminates most human health or environmental threats posed by pollutants in wastewater, eliminating >90% of biochemical oxygen demand ($BOD_5$), >99.99% of fecal coliforms, >99.9% of viruses, and 0–100% of total phosphorus (depending on site-specific soil conditions). Total nitrogen may be reduced by 10–20%. Concentrations of many other chemicals and metals may be reduced by large or small amounts, depending on the contaminant type and concentration and the nature of the soil horizon into which they are discharged.

### Physical and Chemical Characteristics of Contaminants that Affect Their Fate and Transport

Various contaminants in OWTS effluent react in different ways to the treatment processes that take place in the treatment system and in the soil of the dispersal system. Contaminants can be soluble, sorb onto suspended materials, evaporate, reduce or oxidize, biodegrade, or remain relatively unchanged by these processes. An understanding of the physical and chemical properties of a contaminant is necessary to understand the mechanisms involved in the environmental fate and transport of OWTS pollutants of concern, and therefore to achieve appropriate OWTS system design and siting.

#### *Solubility*

Water solubility is the potential for a compound to dissolve in water. The less soluble a compound is in water, the more likely it is to sorb onto suspended particulate matter or soil. A compound is considered hydrophilic if it has an affinity for water and hydrophobic if it is insoluble, has very low solubility in water, or is resistant to wetting or hydration. A soluble compound is more likely to travel through soils.

#### *Sorption Potential*

Adsorption and desorption are processes that are fundamental to understanding the fate and transport of contaminants. Most organic contaminants of concern for which values are available (see Table 4.1-6) have an intermediate (rather than low or high) potential to sorb to sediments and particulate organic matter.

**Table 4.1-6**
**Cation Exchange Capacity for Different Soil Textures**

| Soil Texture | CEC (milliequivalents per 100 grams of soil) |
|---|---|
| Sands (light colored) | 3–5 |
| Sands (dark colored) | 10–20 |
| Loams | 10–15 |
| Silt loams | 15–25 |
| Clay and clay loams | 20–50 |
| Organic soils | 50–100 |

Source: WSU 2004

#### *Evaporation Potential*

Most common organic compounds in wastewater have a low potential to evaporate or be released into the atmosphere through evapotranspiration in an OWTS dispersal field under ambient conditions. Ammonia, however, is an example of one compound that evaporates more readily under ambient conditions and, if not oxidized to nitrate, may do so when it reaches soil or is exposed to air in the dispersal field.

## Soil Properties that Affect Contaminant Fate and Transport

The relative effectiveness of the OWTS dispersal system in the treatment and removal of contaminants, especially pathogens, is dependent on the complex physical, chemical, and biochemical characteristics of the soil and the characteristics of the OWTS wastewater contaminants discussed above in "Physical and Chemical Characteristics of Contaminants that Affect Their Fate and Transport." Various properties of soil play a role in the transformation, retention, and degradation of contaminants in OWTS effluent after the effluent enters the soil through the dispersal field. An understanding of these soil properties is necessary to understand the mechanisms involved in the environmental fate and transport of OWTS pollutants of concern.

As contaminants flow downward and laterally through the soil, they may be changed through a variety of processes (e.g., filtered, absorbed, volatilized, neutralized, adsorbed, hydrolyzed, attenuated, reduced/oxidized). They may be broken down by aerobic, facultative, and anaerobic organisms, which may include organisms such as bacteria, fungi, protozoa, algae, and earthworms, all of which reduce the organic content of effluent through their metabolic processes.

Soil is complex and variable, and its effectiveness at attenuating contaminants from OWTS effluent is determined by many factors, including depth to groundwater (Exhibit 4.1-5), soil type, soil chemistry, soil texture (Exhibit 4.1-6), soil structure and depth, moisture, and activity in the aerobic vegetative root zone where chemical and organic substances are taken up or broken down. Specific soil conditions, such as oxygen content, pH, salinity, temperature, and moisture affect the community of soil microorganisms that are essential for breaking down and decomposing OWTS effluent (described in Chapter 2.0, "Background and Project Description"). Following is a brief description of some of the more important soil properties and components of soil that help determine site suitability and appropriate OWTS design.

### *Oxidation-Reduction Potential*

Oxygen content of the soil will affect the soil's ability to remove additional contaminants before the treated effluent reaches groundwater. Oxidation-reduction potential, or "redox" potential is closely related to oxygen concentration. Low oxygen concentrations usually lower the redox potential, and higher concentrations raise it. Redox potential is the tendency of a chemical compound or substance to acquire electrons and thereby be reduced. In solution with water, the reduction potential of a chemical compound is the tendency of the substance to either gain or lose electrons when it is subject to the introduction of a new compound. A solution with a higher reduction potential will have a tendency to gain electrons from other compounds (i.e., oxidize them) and a solution with a lower reduction potential will have a tendency to lose electrons to other compounds (i.e., reduce them).

### *Redoximorphic Features*

Redoximorphic features include iron nodules and mottles that form in seasonally saturated soils by the reduction, translocation, and oxidation of iron and manganese oxides (EPA 2002). The presence of one or more of these features in the soil indicates that the soil suggests that the surrounding soil is periodically or continuously saturated and has been anaerobic for a period of time. Saturated soils prevent reaeration of the vadose zone below dispersal fields and reduce the hydraulic gradients necessary for adequate drainage, which can lead to surfacing effluent. Therefore, OWTS siting where soil shows redoximorphic features may indicate a high water table and potential for wastewater to surface during high rainfall or OWTS failure.

On the other hand, the absence of redoximorphic features is not an indication that the soil has not been saturated. Redoximorphic features in soil largely result from oxidation-reduction reactions that are biochemically mediated and therefore do not occur in soils with low amounts of organic carbon, high pH (more than 7 standard pH units), low soil temperatures, or low amounts of iron, or where the groundwater is aerated.

### *Soil pH*

The pH scale is a measure of the acidity or alkalinity of a solution in terms of its relative concentration of hydrogen ions. The pH scale ranges from 0 to 14, with pH 7 (the hydrogen ion concentration in pure water) being neutral. Most soils are in the range between pH 3 and pH 10. Acidic conditions involve a pH less than 7; alkaline conditions involve a pH greater than 7.

Complexation (the process of binding or stabilizing metallic ions by means of creating an inert compound) by organic matter in natural waters and wastewater systems occurs when an organic chemical binds to a receptor, and this process is affected by the pH of the solution (Manahan 1994). Acidic conditions can reduce the sorption of metals in soils, leading to increased risk of metals entering groundwater.

### *Cation Exchange Capacity*

Because the amount of naturally occurring organic matter in the soil below the infiltrative surface is typically low (EPA 2002), the cation exchange capacity (CEC) of the soil and the soil solution pH control the mobility of metals below the infiltrative surface. The CEC represents the number of cations that can be adsorbed to a unit mass of soil and is normally expressed as milliequivalents per 100 grams dry soil. In general, soils with higher clay content and more organic matter have higher CEC values and so more cations per unit mass will attach to the soil molecules, resulting in a higher degree of metals retention from effluent. Examples of CEC values for different soil textures are shown in Table 4.1-6.

### *Soil Texture and Structure*

Soil texture describes the relative proportion of different grain sizes of mineral particles in a soil. Coarse-textured soils contain a large proportion of sand, medium textures are dominated by silt, and fine textures are primarily clay. The soil texture consists primarily of sand, silt, and clay particles of less than 2 millimeters in diameter, and the proportion and size of each constituent affect the soil's filtration capacity and permeability (Exhibit 4.1-6). Soil structure is defined by the way individual particles of sand, silt, and clay are assembled. Single particles when assembled appear as larger particles. These are called aggregates. Aggregation of soil particles can occur in different patterns, resulting in different soil structures. Soil texture and structure play an important role in the formation of micro- and macropores respectively, and along with other chemical, biological and physical components of the soil, they affect the porosity of the soil, and thus, the flow and residence time of water in the soil.

The infiltration or percolation rate, measured as hydraulic conductivity (k), is the rate at which water flows through a soil horizon (Table 4.1-7). High porosity soils typically have larger pores and as a result give rise to fast-draining soils that can accommodate a higher application rate of OWTS effluent to the dispersal field than slow-draining soils. However, fast-draining soils often have less treatment capacity because the physical, chemical, and biochemical processes of contaminant attenuation within the vadose zone have less time to work on contaminants in the effluent, especially pathogens. A coarse soil of sand particles mixed with rock, for instance, is not well suited for filtering contaminants from effluent because wastewater moves quickly through the large pore spaces created by the large particle sizes without adequate retention time for remediation by all of the chemical, biological, and physical processes that may reduce some effluent contaminants. An extreme example of this circumstance would be a case where most of the soil mantle is fractured rock. Here, little if any treatment is likely as the water flows rapidly through the soil mantle until it contacts groundwater. Slower draining soils provide more time for the chemical, biological, and physical processes to attenuate contaminants, but require lower application rates per unit area. Therefore, a fine-grained soil with a moderate percentage of silts and clays is more suitable for filtering as it slows the flow of the wastewater, allowing chemical, biological, and physical processes more time to act on the effluent. An extreme example of this case would be expansive, fine-grained clay. Although it filters contaminants from effluent extremely well, it does not allow the effluent to move very rapidly through the soil, which in more extreme instances leads to ponding, eventual failure of the dispersal field, and surfacing effluent.

| Table 4.1-7<br>Porosity and Hydraulic Conductivity for Representative Substrate Types | | |
|---|---|---|
| Material | Porosity (%) | Hydraulic Conductivity (K), cm/sec |
| **Unconsolidated Deposits** | | |
| Gravel | 25–35 | 1–100 |
| Sand | 30–45 | $10^{-4}$–$10^{-1}$ |
| Silt | 35–45 | $10^{-6}$–$10^{-4}$ |
| Clay | 40–55 | $10^{-9}$–$10^{-6}$ |
| **Rocks** | | |
| Karst limestone | 15–40 | $10^{-4}$–$10^{-1}$ |
| Limestone, nonkarst | 5–15 | $10^{-6}$–$10^{-4}$ |
| Sandstone | 10–25 | $10^{-7}$–$10^{-4}$ |
| Shale | 0–10 | $10^{-11}$–$10^{-7}$ |
| Crystalline rock (fractured) | 1–10 | $10^{-6}$–$10^{-4}$ |
| Crystalline rock (unfractured) | 0–2 | $10^{-11}$–$10^{-9}$ |

Note: Porosity is the ratio of pore volume to total volume
Hydraulic conductivity is the rate of flow in centimeters per second (cm/sec) per unit time per unit cross-sectional area. 1 cm/sec equals 23.62 inches per minute.
Source: Adapted from Schnoor 1996.

### *Biomat Formation*

In an ideal system, a biomat forms at the wastewater-soil interface, or infiltrative surface. This layer of biological growth and inorganic matter may extend as far as 1 inch into the soil matrix. It provides physical, chemical, and biological treatment of the OWTS effluent as effluent migrates toward groundwater. The density and composition of the biomat also controls the rate at which wastewater can move through the infiltrative zone of coarse to medium-textured soils into the vadose zone (see below for more information on the vadose zone). Biomats may not exercise the same degree of control in fine-textured soils, as these soils may be more restrictive to flow than the biomat.

### *Depth of Unsaturated Soil below the Dispersal Field*

One of the most important soil characteristics is the thickness of the unsaturated soil below the infiltrative surface (Exhibit 4.1-5). This zone of unsaturated soil between the ground surface and the groundwater table is known as the vadose zone. A conventional OWTS eventually discharges to groundwater and usually relies on the vadose zone to maximize its treatment potential of the wastewater before the effluent enters the groundwater, although some pollutants will usually remain. The vadose zone typically contains more microorganisms than the saturated zone and has a higher rate of contaminant adsorption. The unsaturated soil allows air to diffuse into the open soil pores to supply oxygen to the microbes that grow on the surface of the soil particles. The OWTS effluent is under a negative pressure potential (less than atmospheric pressure) in the vadose zone because of the capillary and adsorptive forces of the soil matrix. This negative soil moisture potential forces the effluent into the finer pores and over the surfaces of the soil particles, increasing adsorption, filtration, and biological treatment of the wastewater.

A larger thickness of unsaturated soil increases residence time in the soil, allowing the above-noted processes more time to maximize any reduction of contaminants that may be possible, pathogens in particular. Saturated soil, on the other hand, increases flow through the larger soil pores, reducing residence time and the filtering effect of the smaller pores. In addition, lack of oxygen or low oxygen concentration in saturated soils reduces aerobic activity and increases less effective anaerobic activity (EPA 2002, Salvato 1992). For proper OWTS siting (particularly for conventional OWTS that do not have supplemental treatment units), adequate thickness of unsaturated soil below the dispersal field and above groundwater is a crucial element of the treatment process that, in a properly designed and functioning system, allows maximum removal of contaminants that may be possible before effluent reaches groundwater. Failure to provide adequate unsaturated soil thickness can result in inadequate removal of pathogens, leading to violation of water quality objectives for pathogens when those contaminants come into contact with groundwater. Other contaminants pass through to groundwater regardless of the thickness of the unsaturated soil.

### Other Site Conditions that Play a Role in the Fate and Transport of OWTS Contaminants

#### *General Location*

Major factors determining the suitability of an OWTS will be its general location with respect to domestic wells and hydrologic connectivity to groundwater supplies, hydrologic connectivity to surface waters, proximity to impaired surface waters, and density of development of nearby residences or businesses with OWTS. Even if individual systems perform as designed, installation of OWTS can exceed the hydraulic loading capacity of the dispersal fields, which can cause mounding of the water table and lead to contamination of groundwater or surface water resources (EPA 2002). (See Section 4.3, “Land Use and Planning,” for additional discussion of this topic.) Therefore, high density installations of OWTS have the potential to exacerbate the problem of groundwater contamination.

#### *Topography*

Topography, or landscape and landform, determines surface and subsurface drainage patterns that can affect OWTS treatment and dispersal. Topographical features that retain or concentrate subsurface flows (e.g., swales, depressions, floodplains) are not recommended sites for OWTS because they may lead to hydraulic overloading and cause groundwater table mounding and have the potential for the discharge of effluent to the surface. Convex slopes, flat areas with deep, permeable soils, and other landforms promote wastewater infiltration and dispersion through unsaturated soils and reduce the risk of surfacing wastewater. Long, planar slopes or plateaus provide greater flexibility in the design of dispersal systems than ridges, knolls, or other mounded or steeply sloping sites.

## IMPAIRED WATER BODIES

Chapter 3.0, “Regulatory Setting,” contains a description of the process by which surface water bodies are identified as impaired for some form of bacteria or nutrients under Section 303(d) of the Clean Water Act. The types of impairment that are related to OWTS as identified in the 303(d) listings are summarized in Table 4.1-8.

Chapter 2.0, “Background and Project Description,” contains three tables that identify Section 303(d)-listed waters in California:

- Table 2-2 identifies water bodies in California that are listed under Section 303(d) as having bacteriologic and/or nutrient impairment, that are listed as having OWTS contribute to the impairment, and that have adopted TMDLs. If the proposed regulations are adopted, OWTS in areas meeting these conditions would require evaluation and possible replacement (Section 24940).

- Table 2-3 identifies water bodies that meet the conditions indicated in Table 2-2 but also have existing regulatory actions to address the pollution and so would qualify for an exemption that effectively would exempt them from complying with Section 24940.

| Table 4.1-8<br>Types of Impairment Identified as Relating to OWTS in EPA's 2006 Section 303(d) Listings | |
|---|---|
| Pathogen Impairment | Nutrients |
| ► Pathogens | ► Nutrients |
| ► Fecal Coliform | ► Nitrite |
| ► Total Coliform | ► Nitrate |
| ► Bacterial Indicators | ► Nitrate as Nitrogen |
| ► Beach Closure | ► Nitrate as Nitrate |
| ► Enterococci | ► Ammonia |
| ► Enteric Viruses | ► Eutrophic |
| ► High Coliform Count | ► Algae |
| Source: EPA 2006, as provided by State Water Board 2007 | |

- Table 2-4 identifies water bodies that are listed as impaired under Section 303(d) because of nitrogen or pathogens but have not yet had TMDLs adopted by the local Regional Water Board. Any of these water bodies may become subject to the requirements of Section 24940 of the draft regulations once a TMDL is adopted, if OWTS are identified as contributing to the impairment.

Tables 2-2 and 2-3 also identify the type of impairment for which each area is designated. Each of these tables also includes an estimate of the number of homes and businesses within 600 feet of the water body (the method for obtaining those estimates is described in Chapter 2.0).

## 4.1.4 ANALYSIS OF ENVIRONMENTAL IMPACTS

### THRESHOLDS OF SIGNIFICANCE

For the purpose of this analysis, a water quality impact is considered significant if implementation of the proposed project would result in exceeding any of the thresholds identified in Tables 4.1-1 or 4.1-3. These thresholds of significance are based on the California Environmental Quality Act (CEQA) Guidelines (State CEQA Guidelines) and relevant adopted water quality objectives. Consistent with State CEQA Guidelines, a public health impact is considered significant in this analysis if implementation of the proposed project would result in potential for exceeding any of these adopted water quality objectives related to public health.

Implementation of the proposed project would also result in significant public health impacts if it would:

- violate federal, state, or local criteria concerning exposure to pollutants or pathogenic microorganisms (including the Safe Drinking Water Act, federal Occupational Safety and Health Administration workplace standards, food safety laws, and other public health criteria; or

- violate any ambient water quality objective, contribute substantially to an existing or projected water quality violation, or expose sensitive receptors to substantial waterborne pollutant concentrations; or

- create a substantial public health hazard or involve the use, production, or disposal of materials that pose a hazard to people in the area affected.

## APPROACH AND METHODS

The proper siting, construction, and operation of OWTS can affect water quality and public health through various mechanisms. In general, these mechanisms are divided into three categories: construction, operation, and maintenance. Each of these mechanisms provides distinct avenues by which OWTS could affect water quality and public health, as described below.

Construction of OWTS is regulated by local agencies through the land use and development approval process (described in Chapter 3.0, "Regulatory Setting," and in Section 4.3, "Land Use and Planning"). The draft regulations do not alter the authority of local agencies to approve construction of OWTS or the processes by which local agencies determine whether to allow development of specific properties and construction of OWTS on those properties.

OWTS construction procedures typically involve the excavation of trenches and other earthwork that can cause the erosion of soil into nearby streams and other receiving waters, especially if standard best management practices (BMPs) for erosion control are not implemented successfully. This impact mechanism is evaluated below in Impacts 4.1-1 and 4.1-2. In addition, the draft regulations (Section 30040) could affect the number of OWTS installed in areas that have been designated as impaired under Section 303(d) of the Clean Water Act. The potential increase in installation in these areas is addressed as well.

After they are operating, different types of OWTS (described in Chapter 2; also see Appendix D) treat the pollutants found in wastewater to varying levels, and then discharge the treated effluent and its remaining contaminants into the soil and then groundwater below the dispersal fields. The commonly used types of dispersal systems, including dispersal trenches, seepage pits, mound systems, gravel-less chambers, and evapotranspiration and infiltration systems, are discussed in Chapter 2 in this document. Some of these pollutants, if not adequately removed, can eventually reach nearby surface waters and may create a public health risk or could adversely affect other beneficial uses.

The primary method used in the water quality and public health impact analysis consists of comparing water quality objectives (Tables 4.1-3 and 4.1-4) to projected concentrations expected to result from the proposed project. The primary contaminants of concern were determined through the likelihood of their presence in OWTS effluent, their typical concentrations, their physical and chemical characteristics in soil and groundwater, and consultation with State Water Board staff. This analysis evaluates the projected concentrations of these constituents at the point where OWTS effluent contacts groundwater (the point of compliance for water quality objectives under the Porter-Cologne Act). Drinking water standards are used because groundwater is defined as having municipal and domestic beneficial uses (such as drinking water) unless specifically noted otherwise, and the drinking water standards are the most restrictive.

The impact headings below make a distinction between "direct" and "indirect" impacts. State CEQA Guidelines Section 15064(d) provides guidance on the definition of these terms and how to assess such effects in an EIR:

1. A direct physical change in the environment is a physical change in the environment that is caused by and immediately related to the project.

2. An indirect physical change in the environment is a physical change in the environment that is not immediately related to the project, but which is caused indirectly by the project and is still reasonably foreseeable.

3. An indirect physical change is to be considered only if that change is a reasonably foreseeable impact that may be caused by the project. A change that is speculative or unlikely to occur is not reasonably foreseeable.

It should be noted the key term "reasonably foreseeable" is not further defined in either CEQA or the State CEQA Guidelines.

Given the guidance summarized above, the types of potential impacts addressed as direct impacts are those that are more likely and certain to occur than the more uncertain impacts covered as indirect impacts. Although some of the adverse potential effects addressed as indirect impacts may be uncertain, this EIR is intended to fully disclose potential impacts of the project, taking into account the complexity of the issues and the considerable interest expressed in these issues during the project's scoping process.

## SUMMARY OF KEY PROJECT COMPONENTS

Section 2.11 in Chapter 2, "Background and Project Description," describes the major elements of the draft regulations. With regard to the analysis of impacts on water quality and public health, the following elements of the draft regulations (divided by the type of systems being addressed) are of particular importance.

### New and Existing Systems

Owners of new and existing OWTS with onsite domestic wells must sample groundwater within 30 days of installation, or within 1 year of enactment of the draft regulations for existing systems, and every 5 years thereafter (Section 30002[s]). Groundwater samples must be analyzed by a laboratory certified by the California Department of Public Health.

All septic tanks must have solids levels inspected at least every 5 years to ensure that the septic tank is pumped before solids begin to interfere with the operation of the OWTS (Section 30002[u]).

### New Systems

For new systems, proper siting, soils analysis, and groundwater studies would be required (Sections 30012, 30014). Requirements include having site soil permeability equal to or greater than the hydraulic loading of OWTS wastewater and meeting the dispersal system requirements and surface application rates indicated in the draft regulations (Section 30014, Figure 1). The vertical separation and depth to groundwater must comply with minimum standards in Section 30012 (3 feet for conventional systems, 2 feet for OWTS with supplemental treatment units) and the OWTS design must meet application rates based on soil texture in the draft regulations (Section 30014, Table 2).

### New and Replaced Systems

OWTS shall be designed to disperse effluent to subsurface soils in a manner that maximizes shallow unsaturated zone treatment and aerobic decomposition of soluble and particulate organic compounds and other pollutants in the effluent (Section 30002[b-d]).

Construction requirements have been established for septic tanks: Effluent filters (3/16 inch) must be included on all new and replaced septic tanks (Section 30002[r]); access opening risers must be placed within 6 inches of grade and must be secured (Section 30002[o]); and tanks must meet the International Association of Plumbing and Mechanical Officials (IAPMO) standards or be certified as meeting industry standards (Section 30002[p]).

With the exception of property owners, only certain licensed contractors may install OWTS (Section 30002[g]).

Cesspools can no longer be used for new and replaced OWTS (Section 30002[m]), and restrictions are placed on the construction and use of seepage pits (Section 30014[k]).

### Supplemental Treatment Units

OWTS with supplemental treatment units are allowed in more sensitive areas and have more stringent performance standards (Section 30013) on the basis that those systems operate in a manner that provides an additional level of treatment and thus greater protection of human health and the environment.

Sections 30013(e–h) contain requirements for STS monitoring, automatic warnings in the event of system malfunction, and quarterly inspections for disinfection units, at a minimum. All OWTS using supplemental treatment units must be designed by a qualified professional, as is required for a conventional OWTS, and must function as intended. An independent third-party certification protocol is required to ensure proper functioning.

### OWTS near Impaired Surface Waters

Section 30040 establishes a specific, more stringent set of requirements for OWTS located in areas within 600 feet of a water body that has been listed as impaired by bacteria or nutrients under Section 303(d) of the Clean Water Act and for which a Regional Water Board has determined in an adopted TMDL that OWTS contribute to the impairment of the water body (see Table 2-2, Exhibits 3-1a–f, and Appendix E). In these areas, owners of existing OWTS must either obtain a study showing that their systems do not contribute to the impairment or convert their OWTS to include supplemental treatment (Section 30040[b]). New OWTS constructed in these areas must include supplemental treatment that addresses the OWTS-related impairment (Section 30040[a]). Exemptions are allowed for areas where the Regional Water Board has adopted a TMDL requiring implementation of a wastewater management plan (Section 30040[d]); Table 2-3 identifies areas that currently meet the requirements for this exemption. Table 2-4 lists areas in California that are within impaired areas but do not yet have adopted TMDLs; once TMDLs are adopted for these areas (as required by federal law), some of these areas may be subject to the requirements of Section 30040.

### Targeted Areas of Impairment

As described above, a key portion of the draft regulations focuses on areas that are (1) within 600 feet of a water body that (2) has been listed for bacteriologic and/or nutrient impairment under Section 303(d) of the Clean Water Act (3) for which the Regional Water Board has adopted a TMDL (4) that designates OWTS as contributing to the impairment. For the purposes of this analysis, areas that meet this four-part definition are referred to as "targeted areas of impairment." The term is intended to clarify that only areas adjacent to certain impaired waters in California, rather than all water bodies designated by EPA as impaired in California, would be affected by the additional requirements in the proposed regulations. Targeted areas of impairment are listed in Table 2-2 and shown in Exhibit 3-1a–f. More detailed maps showing these areas are provided in Appendix E of this draft EIR.

## IMPACTS OF THE PROPOSED PROJECT AND MITIGATION MEASURES

### Direct Construction-Related Impacts

IMPACT 4.1-1 **Direct Impacts Associated with Construction of OWTS in Areas Other Than Targeted Areas of Impairment.** *While the potential exists for OWTS-related construction to result in water quality impacts related to sedimentation and erosion, the likelihood of uncontrolled releases of sediment from erosion or other releases of pollutants from such activities is small. These activities would be minimal and widely distributed throughout the state, except in targeted areas of impairment, and would be associated with other development on generally the same sites. The proposed regulations do not affect where development would occur. For these reasons, water quality impacts relating to typical ground disturbance from OWTS installation, repair, replacement, and upgrade in areas other than targeted areas of impairment are considered* ***less than significant.***

Mandatory septic tank inspections and groundwater monitoring requirements included in the draft regulations could lead to an increase in OWTS repairs, replacements, and upgrades. Because systems are currently not inspected on a regular basis and groundwater monitoring at wells is not common, these requirements could lead to an increase in OWTS repairs, replacements, and upgrades as OWTS owners and their neighbors become increasingly aware of OWTS operational or public health issues.

In general, most OWTS installation, replacement, repair, or upgrade projects would disturb less than 1 acre, and are regulated by the local land use agency with regard to implementation of appropriate siting and erosion control measures; the draft regulations would not remove or otherwise affect this authority. For instance, as identified in Tables 3-1a, 3-1b, and 3-2, the example counties and cities have requirements in place for siting of OWTS that include sediment and erosion control measures. The Regional Boards, in addition to the cities and counties, also have requirements in place for siting of OWTS that include sediment and erosion control measures. While existing BMPs at the local level may be adequate to avoid significant water quality impacts in many or most situations, local agencies vary widely in the management measures required, and there may be some situations where those BMPs are not sufficient to avoid such impacts. Therefore, in instances where OWTS being installed, replaced, repaired, or upgraded would disturb less than 1 acre, the potential exists for construction to affect water quality related to sedimentation and erosion. However, the likelihood of uncontrolled releases of sediment from erosion or other releases of pollutants from such activities is small. Furthermore, these impacts, as with the initial construction impacts described in “Approach and Methods” above, would be minimal and widely distributed throughout the state, and associated with other development on generally the same sites; for instance, a home and septic system would be constructed on the same site, and future repairs would occur on that site. The proposed regulations do not affect where development would occur. For these reasons, water quality impacts relating to typical ground disturbance from OWTS installation, repair, replacement, and upgrade in areas other than targeted areas of impairment are considered less than significant.

In the few instances where the area of ground disturbance affected by construction of new OWTS facility infrastructure and construction of staging areas would exceed 1 acre, OWTS installation, replacement, repair and upgrade would be subject to the requirements of the statewide NPDES storm water general permit for construction activity (Order 99-08-DWQ). In these situations, before OWTS construction activities can be approved, the project applicant is required under existing state law to apply for permit coverage. This would result in the project applicant preparing a storm water pollution prevention plan (SWPPP) and any other necessary engineering plans and specifications for pollution prevention and control. The SWPPP would identify and specify BMPs that must be in place throughout all site work and construction. Typical BMPs include the following:

- Use erosion and sediment control measures, including construction techniques that would reduce the potential for runoff and minimize discharge of sediment into nearby drainage conveyances; these BMPs may include silt fences, staked straw bales or wattles, sediment/silt basins and traps, geofabric, sandbag dikes, and temporary vegetation.

- Establish permanent vegetative cover to reduce erosion in areas disturbed by construction by slowing runoff velocities, trapping sediment, and enhancing filtration and transpiration.

- Use drainage swales, ditches, and earth dikes to control erosion and runoff by conveying surface runoff down sloping land, intercepting and diverting runoff to a watercourse or channel, preventing sheet flow over sloped surfaces, preventing runoff accumulation at the base of a grade, and avoiding flood damage along roadways and facility infrastructure.

- Identify the means of disposal of waste materials (i.e., brush, vegetation) removed from the site.

- Identify pollutants that are likely to be involved in construction activities that could be present in stormwater drainage and nonstormwater discharges and in other types of materials used for equipment operation.

- Establish spill prevention and contingency measures, including measures to prevent or clean up spills of hazardous waste and of hazardous materials used for equipment operation, and emergency procedures for responding to spills.

Several technical studies (California Stormwater Quality Association 2003, Huffman & Carpenter 2003, and EPA 1999) have established that water quality control features such as revegetation, erosion control measures, and detention and infiltration basins are successful techniques for avoiding or minimizing construction-related water quality impacts (e.g., metals and organic compounds from stormwater are typically filtered out within the first few feet of soil beneath retention basins for groundwater). Technical studies by Huffman and Carpenter (2003) demonstrated that the use of various BMPs, such as source control, detention basins, revegetation, and erosion control, have maintained surface water quality conditions in adjacent receiving waters.

Given the adequacy of the existing NPDES, and SWPPP program where applicable (for areas of disturbance of 1 acre or more) and the effectiveness of BMPs when used appropriately in such situations, the project's potential construction-related impacts on water quality are also considered less than significant for OWTS construction disturbing 1 acre or more.

No mitigation is required.

IMPACT 4.1-2 **Direct Impacts Associated with Construction of OWTS in Targeted Areas of Impairment.** *The draft regulations would require most owners of conventional OWTS in targeted areas of impairment to assess and potentially convert their existing systems to OWTS with supplemental treatment units (Section 30040); normal construction permit processes would not be affected. Conversion of conventional OWTS to OWTS with supplemental treatment would require some digging, trenching, grading, and other earthwork and the use of heavy construction vehicles on previously developed parcels. In cases of widespread conversion of systems and the resulting construction in these areas could lead to erosion, sedimentation, and deposition of hazardous materials on and off-site that could result in violation of state water quality regulations and adverse water quality impacts on surface water bodies. This impact is considered* ***potentially significant.***

Potentially, the draft regulations would require most owners of conventional OWTS in targeted areas of impairment to convert their existing conventional systems to OWTS with supplemental treatment units (Section 30040) within a 2-year time frame. This activity would require digging, trenching, grading, and other earthwork using heavy equipment within 600 feet of impaired surface waters. In the short term, this regulatory requirement could directly affect an estimated 2,798 existing conventional systems that would need to be upgraded in targeted areas of impairment (Table 2-2). Over the long term, more existing conventional systems (possibly as many as an estimated 14,654) could eventually be affected near some of the additional 303(d) water bodies that have been listed for bacteriologic or nutrient impairment but do not yet have adopted TMDLs (Table 2-4).

As explained above under Impact 4.1-1, areas exist where local BMP requirements related to sedimentation and erosion control for construction activities disturbing less than 1 acre are not sufficient to avoid water quality impacts.  Where targeted areas of impairment are located in jurisdictions with such inadequate BMP requirements, compliance with the proposed draft regulations could result in impacts to water quality because these activities would tend to involve large numbers of parcels in a given area within a short timeframe.  Under these conditions, the soil loosened during grading and releases of fluids or fuels caused by accidental spills from construction vehicles, if mobilized and transported off-site in runoff, could lead to erosion, sedimentation, and deposition of hazardous materials off-site that could be sufficient to cumulatively result in violations of state water quality regulations and adverse water quality impacts on surface water bodies. Therefore, while the regulations would not alter the construction permit process in any jurisdictions, and they do not address water quality impacts from construction, the regulations would cause substantial additional construction in targeted areas of impairment that could result in adverse effects on water quality of nearby impaired surface water bodies. For this reason, this impact is considered potentially significant.

**Mitigation Measure 4.1-2: Modify the Proposed Regulations to Require Implementation of Erosion and Sediment Control Measures during OWTS-Related Construction Activities in Targeted Areas of Impairment.**

Modify Article 4: "Protecting Impaired Surface Water," Section 30040 "SWRCB – Applicability and Requirements" to require implementation of construction BMPs that reduce the potential for runoff and minimize discharge of sediment into nearby drainage conveyances during all construction activities related to installation of new OWTS or replacement of existing OWTS in targeted areas of impairment. These BMPs may include silt fences, staked straw bales or wattles, sediment/silt basins and traps, geofabric, sandbag dikes, and temporary vegetation.

***Implementation:*** The application of Mitigation Measure 4.1-2 is the responsibility of the State Water Board.

***Significance after Mitigation:*** Implementing Mitigation Measure 4.1-2 would reduce water quality impacts associated with widespread conversion of conventional OWTS in targeted areas of impairment to a ***less-than-significant*** level because this requirement would prevent large-scale mobilization and transport of sediment and hazardous materials off-site during OWTS construction-related activities.

### Direct Impacts Associated with Pathogen Contamination

| | |
|---|---|
| IMPACT 4.1-3 | Direct Impacts Associated with Pathogen Contamination Caused by Operation of OWTS Statewide. *Pathogens that cause communicable diseases in humans are found in wastewater effluent and because OWTS effluent discharged to subsurface dispersal systems may eventually reach groundwater and surface waters used for drinking water and/or recreation, OWTS discharges pose a public health risk. Attenuation and removal of pathogenic bacteria, viruses, and protozoa in the soil is accomplished through such mechanisms as microbial predation, filtration/adsorption, and inactivation (die-off), which, in turn, are affected by the depth, texture, and structure of the soil, hydraulic loading rates, effluent quality, and various other physical and chemical soil conditions, such as temperature, pH, and oxygen. Mandatory septic tank inspection, and requirements for use of septic tank effluent filters, qualified professionals, shallow dispersal system designs, and supplemental treatment would lead to improved effluent quality and system performance for existing and replaced OWTS statewide where current related regulations include less stringent requirements. Discharges from new OWTS installed after adoption of the proposed regulations would represent additional potential sources of pathogens to groundwater. However, the effluent quality from these new systems would aid in preventing surfacing effluent and would help to ensure protection of groundwater and surface water quality. This impact is considered* ***less than significant****.* |

Total coliforms are used in the draft regulations as an indicator of the presence of pathogens, based on their use as an indicator in drinking water, as required in California regulations (Title 22, Section 64426.1). Mechanisms responsible for retention and removal of pathogenic bacteria, viruses, and protozoa in the soil include microbial predation, filtration/adsorption, and inactivation (die-off). In general, the degree of pathogen attenuation in the soil varies depending on the texture of the soil, depth of soil, hydraulic loading or application rate, physical and chemical soil conditions (e.g., temperature, pH, oxygen) that may be unfavorable for pathogen survival, and other soil conditions that affect residence time and the metabolic processes of resident microbial organisms that may prey on pathogens in the effluent (as described above and shown in Exhibits 4.1-5 and 4.1-6).

Because some or all of the OWTS effluent discharged to a subsurface dispersal system may eventually reach groundwater, and little dispersion or dilution of contaminants is typical once in groundwater, the potential exists for downgradient wells and/or surface waters to become contaminated if they have connectivity to groundwater that is in the direct flow path of one or more OWTS effluent plumes. Pathogens (including protozoa, bacteria, and viruses) that are found in wastewater effluent can cause communicable diseases in humans through direct and indirect body contact or ingestion of contaminated water or shellfish, and therefore pose a public health risk. Numerous investigations have studied the fate and transport of bacteria and viruses in soil and groundwater (Siegrist, Tyler, and Jenssen 2000).

The mechanisms for immobilization of pathogens in the soils are a combination of straining/filtration and adsorption (Siegrist, Tyler, and Jenssen 2000). Experiments have shown that straining can occur if the soil pore spaces are smaller than the bacteria or other pathogen, and it becomes effective when the average pathogen size is greater than the grain size, $d_5$, of the soil (where $d_5$ is the diameter at which 5% of the grains are smaller and 95% are larger) (Updegraff 1983). In addition to grain size, straining is controlled by the amount of mechanical and biological clogging of the soil, the degree of water saturation, and the hydraulic loading rate (Siegrist, Tyler, and

Jenssen 2000). Studies have shown that a mature biomat can be extremely important in pathogen removal (Van Cuyk et al. 2001b). These processes can effectively reduce or eliminate bacteria and parasites.

As stated in the discussion of pathogens in “Water Quality and Public Health Risks from OWTS” in Section 4.1.2 above, the retention and die-off of most, if not all, observed pathogenic bacteria occur within 2–3 feet of the soil infiltrative surface in a properly designed and sited, normally functioning OWTS (depicted in Exhibit 2-1) (Anderson et al. 1994; Ayres Associates 1993a, 1993b; Bouma et al 1972; McGaughey and Krone 1967), and most bacteria are removed within the first 1 foot of distance vertically or horizontally from the trench-soil interface at the infiltrative surface of coarse soils with a mature biomat (University of Wisconsin 1978).

Virus removal in soils is more problematic. According to the *Onsite Wastewater Systems Manual* (EPA 2002), viruses can be both retained and inactivated in soil; however, they can also be retained but not inactivated. Soil factors that decrease virus survival include warm temperatures, low moisture content, and high organic content (Sobsey 1983). If not inactivated, viruses can persist for long periods, accumulate in soil, and subsequently be released because of changing conditions, such as prolonged peak OWTS flows or heavy rains. This is primarily true for viruses. When the soil pores are larger than the pathogen, adsorption is the dominant retention mechanism and is therefore very important in virus removal (Siegrist, Tyler, and Jenssen 2000). Once in the saturated zone, viruses have been known to travel more than 1000 feet in groundwater. However, laboratory and field studies have shown that passage through 2 to 3 feet of sandy soil can achieve significant and effective virus removal (Anderson, Lewis, and Sherman 1991; Ayres Associates 1993b; Van Cuyk et al. 2001a).

The pathogen adsorption effectiveness of a soil is also dependent on the degree of biofilm development (see Section 2.3.1, “Aerobic Treatment Units,” for more information on biofilm) and the content of organic matter, cation exchange capacity, and other physical and chemical characteristics as discussed above and in Appendix F. Iron oxides on the soil surfaces also enhance adsorption of bacteria and viruses. Die-off of bacteria and viruses can occur in the adsorbed or liquid phase (Siegrist, Tyler, and Jenssen 2000).

#### ***Requirements for Mandatory Septic Tank Inspections and Use of Septic Tank Effluent Filters***

The proposed regulations call for mandatory septic tank inspections (leading to pumping when necessary) for all existing, new, and replaced OWTS, and use of septic tank effluent filters for all new and replaced septic tanks, to prevent solids in the septic tank from passing through to the dispersal field. Mandatory septic tank inspections would be required once every 5 years under the proposed regulations, which has been shown to be a reasonable period within which a septic tank might need maintenance to remove the build-up of excess solids (Bounds 1994). Because the time for solids to build up in septic tanks varies, pumping would not occur at the same frequency as inspections in most cases. Rather, pumping would take place when the level of solids retained in the septic tank reaches a level that would interfere with proper septic tank function (i.e., causing shorter retention times for wastewater in the septic tank) (EPA 2002, Bounds 1994). Section 30002(u) of the proposed regulations recommends that septic tanks be pumped when the combined scum (floating solids) and sludge (settled solids) depth exceeds 25% of the septic tank depth. Effluent filters remove larger particles (>3/16 of an inch in diameter) in the septic tank effluent, and their use would also minimize the passage of solids, especially neutrally buoyant solids, to the dispersal field (Byers 2001). Mandatory septic tank inspections and effluent filter requirements would limit solids passing through from the septic tank into the dispersal field and result in better septic tank effluent quality (Laak 1986).

The improved effluent quality would lead to improved residence time in the unsaturated soil, which would improve soil treatment effectiveness, in particular with respect to pathogens (see “Shallow Dispersal System Design Requirements” below). Therefore, mandatory septic tank inspections and effluent filter requirements would provide environmental benefits, particularly with respect to existing OWTS that would continue to operate or would be replaced for other reasons, because the effluent quality of these current OWTS discharges would likely be improved relative to baseline conditions.

### *Designation of Qualified Professionals*

The proposed regulations require qualified professionals, as defined in Section 30000, to be involved in the following elements of OWTS management:

- soil and site evaluation for new construction or replacement of an OWTS (Section 30002[e]);
- design of new or replaced OWTS (Section 30002[f]);
- preparation of an operations and maintenance manual for all existing, new, and replaced OWTS with STS (Section 30002[i]); and
- site evaluation for groundwater level determination (Section 30012[a]) and seepage pit determination (Section 30014[k]) for new and replaced OWTS.

Qualified professionals are professionally licensed or certified in California to perform certain duties. Requiring a qualified professional to be involved in these various aspects of OWTS management would assure a standard of practice that would improve the level of certainty regarding system function and performance and ensure that depth to groundwater is adequate to achieve effective soil treatment.

### *Shallow Dispersal System Design Requirements*

The proposed regulations require that dispersal systems for new and replaced OWTS be designed and installed at the shallowest depth, and that the dispersal system be sized using application rates that are within the range of recommended/suggested values contained in both the EPA design manuals (EPA 1980, 2002), which are indicative of the long-term acceptance rate (LTAR) of a given soil below the infiltrative surface. These requirements are intended to enhance the effectiveness of soil treatment (maximize aerobic decomposition and pathogen removal) relative to soil treatment effectiveness under existing regulatory conditions.

Aerobic decomposition of wastewater solids is significantly faster and more complete than anaerobic decomposition. Shallow dispersal systems enhance aerobic decomposition of wastewater solids because oxygen delivery is better, and biological activity is greater at or near the ground surface.

The LTAR is the rate at which the OWTS effluent will drain into the soil at a sustained rate for an extended period of time because the rate of the soil clogging process is approximately equal to that of the soil unclogging process (Laak 1986). Application of wastewater effluent below the LTAR reduces the possibility of dispersal system failure and surfacing effluent caused by soil clogging. In addition, application of effluent at or below the LTAR maximizes unsaturated flow and residence time in the unsaturated zone, which facilitates long-term aerobic soil treatment of the wastewater.

The proposed regulations require that all new and replaced conventional OWTS have at least 3 feet of undisturbed soil or earthen material between the bottom of the dispersal system (infiltrative surface) and the seasonal high groundwater level. As described above, the retention and die-off of pathogenic bacteria is nearly complete within 2–3 feet of the soil infiltrative surface in a properly designed and sited, normally functioning OWTS (Anderson et al. 1994; Ayres Associates 1993a, 1993b; Bouma et al 1972; McGaughey and Krone 1967), and according to Van Cuyk et al. (2001a), with support from other studies (Anderson, Lewis, and Sherman 1991; Ayres Associates 1993b; and Higgins 2000) significant removal of viruses can be achieved in 2–3 feet of unsaturated soil. Therefore, the proposed minimum soil depth requirement for new and replaced conventional OWTS would likely ensure that residence time in the unsaturated zone is adequate to achieve the level of pathogen removal necessary to protect groundwater and nearby surface waters from pathogen contamination.

In areas where native soil depths do not meet the minimum requirements, the proposed regulations allow the use of engineered fill for new and replaced OWTS to make up for the lack of adequate soil depth, up to a maximum of

1 foot. Because of the nature of the fill and concern for rapid permeability of the material (uniform, single-grain material), the proposed regulations require a 1.5 to 1 ratio of fill to replaced native soil. The 50% increase in fill over native soil provides a factor of safety to ensure that these new and replaced systems have sufficient soil to provide adequate residence time in the unsaturated zone. This factor of safety is reasonable because sand is a granular soil texture that usually contains no structure and therefore primarily relies on space between the soil particles, usually resulting in rapid permeability (EPA 1980, 2002).

The application rates in the proposed regulations are based on the application rates specified in the North Coast Regional Water Board's Water Quality Control Plan (North Coast Regional Water Board 2007). Application rate requirements in California currently vary slightly from region to region and jurisdiction to jurisdiction (Bradley, pers. comm., 2008; see Tables 3-1a, 3-1b, 3-2). Implementation of the application rate requirements in the proposed regulations would likely lead to a lower incidence of surface failures, particularly in areas where existing regulations currently allow installation of systems in very slow-draining soils, because installation of new OWTS in areas with percolation rates slower than 120 minutes per inch (MPI) would no longer be permitted on newly created lots. Reducing the number of failures caused by surfacing effluent would result in improved protection of public health and nearby surface water quality. In areas with fast-draining soils and domestic onsite wells, implementation of the proposed application rate requirements to new and replaced OWTS would result in longer residence times in the unsaturated zone, and thus, greater pathogen removal and improved protection of nearby wells.

### *Requirements for Use of Supplemental Treatment Components*

The proposed regulations would also provide local agencies and the Regional Water Boards with the authority to require the use of supplemental treatment components with any existing or new OWTS where conditions provide less than 3 feet but more than 2 feet of continuous undisturbed, unsaturated soil below the bottom of the dispersal system, and/or where additional treatment is needed to protect water quality and public health (Section 30013 and 30014[d]).

The specific performance requirements contained in Section 30013(a) would require OWTS with supplemental treatment units to be designed to reduce BOD and total suspended solids (TSS) concentrations, and produce effluent that has a 30-day average BOD concentration that does not exceed 30 mg/l and a 30-day average TSS concentration that also does not exceed 30 mg/l. These requirements are intended to result in improved effluent quality that would lead to a slowing of soil clogging processes and improved residence time in the unsaturated (vadose) zone. Longer residence times in the unsaturated soil, as described above, can result in improved pathogen removal.

However, soils vary in their ability to effectively remove pathogens and provide protection of water quality and public health. Thin, fast-draining soil with large pore spaces and low organic content (e.g., sand) typically remove less contaminants than thick, slow-draining, fine-textured soil with higher organic content (e.g., silt-clay loam). Therefore, the proposed regulations also allow for the use of supplemental treatment units designed to provide disinfection, in addition to BOD and TSS removal, and these requirements would be specifically required in targeted areas of impairment next to pathogen-impaired water bodies. All existing OWTS that contribute to this type of impairment and all new OWTS in such targeted areas of impairment would be required to include a supplemental treatment unit that provides disinfection.

As presented in Section 2.3.3, "Disinfection Systems," various types of disinfection units are available, including chlorination, ultraviolet light, and ozonation. Each of these types of treatment is effective when the unit is appropriately operated and maintained. (See Appendix F for more detailed information about the effectiveness of these processes.)

The proposed regulations include two related disinfection performance requirements based on soil conditions (Section 30013[c][1] and [2]). The two performance requirements are intended to achieve the amount of pathogen reduction associated with a properly sited and designed conventional OWTS and are based on the State of Arizona's OWTS regulations (Title 18, R18-9-A312).

In areas with highly permeable soils, areas with very thin soils, and soils with a high percentage of rock fragments that would not provide adequate retention time and therefore the level of treatment necessary to effectively remove pathogens before entering groundwater, the draft regulations contain a limit of 10 most probable number (MPN)/100 milliliters (ml) total coliform bacteria. This is very close to the maximum level of disinfection achievable and leaves a very small population of viable microorganisms for the soil environment to remove to limit or exclude pathogens from entering groundwater. For sites with soils of adequate depth that can be expected to provide reasonable treatment for pathogens (soils that contain more fines mixed with sand and other medium- to fine-textured soils), the proposed performance requirement of 1,000 MPN/100 ml total coliforms is intended to remove pathogens by several logs and allow the soil environment to remove the remainder of the pathogens (EPA 2002).

The siting criteria for OWTS with supplemental treatment units and the BOD, TSS, and disinfection performance requirements described above would likely be sufficient to achieve effective removal of pathogenic bacteria, parasites, and viruses from effluent before it is discharged to soils and would effectively reduce the risk of pathogens reaching groundwater and contaminating drinking water supplies when using shallow pressurized drip or orifice dispersal or an evapotranspiration and infiltration (ETI) system.

### *Conclusion*

With respect to pathogens, implementation of the proposed requirements discussed above would lead to improved effluent quality from existing and replaced OWTS in targeted areas of impairment, and all other areas of the state where current regulations include less stringent requirements related to inspection and maintenance, system siting and design, or supplemental treatment performance. Although, discharges from new OWTS installed after adoption of the proposed regulations would represent additional potential sources of pathogens to groundwater, the effluent quality from these new systems would aid in preventing surfacing effluent and would help to ensure protection of groundwater and surface water quality. This impact is considered less than significant.

No mitigation is required.

IMPACT 4.1-4 **Direct Impacts Associated with Pathogen Contamination Caused by Operation of OWTS with Seepage Pits Statewide.** *Where sites are otherwise unsuitable for shallow pressurized drip or orifice dispersal or an ETI system because of either soil properties or the amount of area available at the site, and certain soil depth and depth to groundwater requirements are met, the proposed regulations would allow the use of seepage pits for dispersal of effluent (Section 30014[k]). Disinfection would be required for some systems where there is less than 10 feet of soil below the bottom of the seepage pit, the level of which would depend on the available soil depth. This section of the proposed regulations would allow dispersal of OWTS effluent directly into fractured bedrock environments, where flow paths that intersect wells or surface water may be short circuited by fractures. This poses a public health risk, particularly where the OWTS does not provide the maximum level of disinfection and/or there is less than 2 feet of soil below the bottom of the seepage pit, through direct or indirect body contact or ingestion of contaminated water or surface waters. Therefore, the impact of operation of OWTS with seepage pits is considered* ***potentially significant.***

Where sites are otherwise unsuitable for shallow pressurized drip or orifice dispersal or an ETI system because of either soil properties (e.g., shallow restrictive layer [clay] underlain by suitable soils) or the amount of area available at the site, the proposed regulations would allow local agencies or the local Regional Water Board to permit the use of seepage pits for dispersal of effluent from new and replaced OWTS provided there is at least 10 feet of separation to seasonal high groundwater below the bottom of the seepage pit (Section 30014[k]). Under such conditions, and when a minimum of 10 feet of soil also exists below the bottom of the seepage pit, no additional treatment beyond that provided by a septic tank would be required before effluent is discharged to the seepage pit. Where less than 10 feet of soil exists below the bottom of the seepage pit, the proposed regulations would require that the OWTS include supplemental treatment units designed to remove BOD and TSS, and provide disinfection as follows:

1. Where separation to groundwater is at least 10 feet, and more than 2 feet but less than 10 feet of sandy soil or soil with percolations rates between 1 and 10 MPI exists below the bottom of a seepage pit, the proposed regulations would require OWTS with STS designed to remove BOD pursuant to Section 30013[b], as well as remove TSS and perform disinfection at levels that achieve an effluent total coliform concentration before discharge to the seepage pit of 10 MPN/100 ml pursuant to Section 30013(c)(1).

2. Where separation to groundwater is at least 10 feet, there is between 2 and 10 feet of soil below the bottom of the seepage pit, and soil percolation rates are greater than 10 MPI or the soil consists of a soil texture other than sand, the proposed regulations would require OWTS with supplemental treatment units designed to remove BOD pursuant to Section 30013[b], as well as remove TSS and achieve a total coliform concentration of 1000 MPN/100 ml pursuant to Section 30013(c)(2).

3. Where separation to groundwater is at least 10 feet, and there is less than 2 feet of soil below the bottom of the seepage pit, the proposed regulations would allow the use of seepage pits provided the OWTS included a supplemental treatment unit designed to meet the performance requirements in Section 30013(b) and (c)(1) before discharge to the seepage pit.

The requirement in (2) above would allow the use of seepage pits for new and replaced OWTS without the maximum level of disinfection where 2 to 10 feet of soil with a texture other than sand, and/or percolation rates greater than 10 MPI exist above a fractured bedrock environment, and the requirement in (3) above would allow seepage pits to disperse effluent treated to the maximum level of disinfection directly or almost directly (<2 feet of soil) into fractured rock environments. As described in Section 4.1.3.3 “Interaction between OWTS Discharges and Ground- and Surface Waters,” it is difficult to predict the flow path of effluent or the length of time it would take for an OWTS effluent plume to reach groundwater in a fractured rock environment. Nearby domestic wells may or may not be protected from contamination by effluent plumes in the groundwater, depending on the configuration and connectivity of fractures in the subsurface (see condition D in Exhibit 4.1-7). Literature reviews by Hagedorn (1982) and Bicki et al. (1984) identify a number of references that provide evidence that infiltrative surfaces constructed too near fractured bedrock correlate with pathogen contamination of groundwater and surface waters. Because seepage pits are deep and narrow and wastewater application methods vary, saturated flow conditions are common. As a result, the treatment effectiveness of the soil below seepage pits can be significantly reduced. Therefore, while OWTS with disinfection systems that meet the proposed supplemental treatment requirements in Section 30013(c)(1) and (c)(2) would likely provide adequate protection of groundwater with respect to pathogen contamination under the proposed regulations when included as part of an OWTS that uses shallow pressurized drip or orifice dispersal or an evapotranspiration and infiltration (ETI) system because of the added protection provided by the soils below the dispersal system, this may not be the case when OWTS with the same disinfection performance discharge to seepage pits. In particular, when the system does not achieve the maximum level of disinfection and/or there is less than 2 feet of soil below the bottom of the seepage pit, the potential would exist for pathogen contamination of groundwater, and nearby domestic wells and surface waters.

Most, if not all, local ordinances allow domestic wells to be installed as close as 100 feet from an OWTS. Domestic wells, as compared to municipal supply wells, typically draw water from shallower aquifers and have less-stringent (and thus less costly) and less-protective construction requirements (DWR 1981). Whereas municipal supply wells are subject to routine and stringent water quality testing to ensure that the public is not provided with water that exceeds drinking water standards, no such requirements exist for domestic wells. Therefore, in fractured rock environments where OWTS discharge to seepage pits, these systems may not be expected to achieve adequate pathogen removal unless the system includes a supplemental treatment unit that provides the maximum level of disinfection and at least 2 feet of unsaturated soil exists below the bottom of the seepage pit. Although, all new and replaced OWTS with seepage pits in targeted areas of impairment with OWTS-related bacteriologic impairment or both bacteriologic and nutrient impairment, not just those with less than 10 feet of soil below the bottom of the seepage pit and above the limiting layer, would be required to include a supplemental treatment unit that provides the maximum level of protection, the potential would exist for pathogenic microorganisms to reach nearby domestic wells and surface waters that are hydrologically connected to contaminated groundwater, because sufficient unsaturated soil depth may not be provided to achieve the level of pathogen removal needed to be fully protective of groundwater, nearby domestic wells, or surface waters. Therefore, OWTS that discharge to seepage pits, particularly in fractured rock environments, could pose a risk to public health through direct or indirect body contact or ingestion of contaminated water or surface waters. Because the proposed regulations would allow for new and replaced seepage pits to be constructed in fractured bedrock environments, direct impacts associated with pathogen contamination on water quality and public health from operation of new and replaced OWTS with seepage pits throughout the state would be potentially significant.

Mitigation Measure 4.1-4. Modify Section 30014(k)(3) to Require All Seepage Pits to Have At Least 2 Feet of Soil Below the Bottom of the Seepage Pit, and for Seepage Pits with Between 2 and 10 feet of Soil below the Bottom of the Seepage Pit to Include a Supplemental Treatment Unit That Provides the Maximum Level of Disinfection.

Section 30014(k)(3) shall be modified as follows:

(k) Seepage Pits shall be designed based on sidewall area as the infiltrative surface and are allowed where the following conditions apply:

(1) a qualified professional has determined that the site is unsuitable for other types of dispersal systems due to soil properties or amount of area available at the site;

(2) the bottom of the seepage pit is a minimum of ten feet above seasonal high groundwater level; and

(3) the site meets one of the conditions:

(A) A minimum of ten feet of unsaturated, undisturbed soil exists below the bottom of the seepage pit and above the seasonal high groundwater level, impervious layer, or bedrock. All strata to a depth of 10 feet below the pit bottom are free of groundwater in accordance with §30012; or

(B) a seepage pit may have less than 10 feet of unsaturated, undisturbed soil below the bottom of the seepage pit and above the seasonal high groundwater level, impervious layer, or bedrock, but no less than two feet of unsaturated, undisturbed soil, when supplemental treatment components are used to meet the performance requirements specified in §30013(b) and §30013(c)(1).~~;or~~

~~(C) a seepage pit may have less than two feet of unsaturated, undisturbed soil beneath the bottom of the seepage pit when supplemental treatment components are used to meet the performance requirements specified in §24913(b), and §24913(c)(1).~~

***Implementation:*** The application of Mitigation Measure 4.1-4 is the responsibility of the State Water Board.

***Significance after Mitigation:*** Implementing Mitigation Measure 4.1-4 would reduce the impacts associated with pathogen contamination from new and replaced OWTS that use seepage pits for dispersal to a ***less-than-significant*** level because this requirement would result in pathogen levels in discharges from such OWTS that would be sufficient to protect domestic wells and nearby surface waters in fractured bedrock environments from pathogen contamination.

## Direct Impacts Associated with Nitrogen Contamination

IMPACT 4.1-5 Direct Impacts Associated with Nitrogen Contamination Caused by Operation of OWTS in Areas Other than in Targeted Areas Next to Nutrient Impaired Water Bodies. *Most of the nitrogen compounds in OWTS effluent will be nitrified and become nitrate below the infiltrative surface. Once nitrates from OWTS* *reach groundwater, they can travel hundreds of feet as long, narrow, and definable plumes in concentrations that may eventually exceed drinking water standards (EPA 2002). While qualified professional and shallow dispersal system requirements would improve system performance, and some level of denitrification may occur once in the soil under the right soil conditions, total nitrogen concentrations in OWTS effluent may not be sufficiently low to protect water quality or public health, except where the OWTS include a supplemental treatment unit that meets the water quality objective for nitrate-nitrogen in groundwater. Thus, OWTS in areas other than targeted areas of nutrient impairment would have the potential to degrade groundwater quality and adversely affect the beneficial uses of groundwater and surface waters that are hydrologically connected to the groundwater. This is considered a* ***significant*** *impact on water quality and public health.*

As effluent from conventional OWTS, and OWTS with supplemental treatment components that are not designed to reduce nitrogen prior to discharge, travels through the unsaturated zone, most of the nitrogen compounds in the effluent will become nitrate below the infiltrative surface through an aerobic process called nitrification. Once nitrates from OWTS reach groundwater, they can travel hundreds of feet as long, narrow, and definable plumes in concentrations that may eventually exceed drinking water standards (EPA 2002). The direction of groundwater flow, and thus the direction of the OWTS discharge plume, is generally not known, requires a costly study to determine, and can change substantially with seasonal variations or groundwater pumping. In a fractured rock environment, it is rarely possible to predict or determine the direction of OWTS discharge flow, as noted above, and nitrates can travel considerable distances with little or no dilution in these environments (Winneberger 1984).

Until the early 1990s, it was assumed that all the nitrogen applied to the infiltration system, following transformation to nitrate, would ultimately leach to groundwater (Brown, Slowey, and Wolf 1978; Walker et al. 1973a, 1973b). However, Jenssen and Siegrist (1990) found, during a review of several studies, that denitrification, the anaerobic process that converts nitrate to nitrogen gas, can contribute to nitrogen reduction by up to 20% in wastewater percolating through the soil (EPA 2002). Factors found to favor denitrification are fine-grained soils (silts and clays) and layered soils (alternating fine-grained and coarser-grained soils with distinct boundaries between the texturally different layers), particularly if the fine-grained soil layers contain organic material, because the process of denitrification also requires an adequate source of carbon.

### *Designation of Qualified Professionals*

As discussed under Impact 4.1-3 above, the proposed regulations would require qualified professionals, as defined in Section 30000, to be involved in various aspects of OWTS siting, design, and evaluation. These requirements for qualified professionals would assure a standard of practice that would improve the level of certainty regarding system function and performance and ensure that depth to groundwater is adequate to achieve effective soil treatment.

### *Shallow Dispersal System Design Requirements*

The proposed regulations (Sections 30002[b] and 30014[a]) encourage shallow dispersal systems (placing the infiltrative surface high in the soil profile where organic matter in the soil is more likely to be present). As a result, in areas where soil conditions are favorable for denitrification and the existing regulations are less protective, implementation of the proposed regulations would be expected to enhance nitrogen removal below the infiltrative surface of OWTS. However, because soil conditions vary and may not be relied on in all cases to provide adequate denitrification, existing and new OWTS may continue to exceed the 10 mg/l nitrogen standard for groundwater at the point of compliance below shallow dispersal systems. The 10 mg/l nitrogen standard would not be exceeded if the OWTS includes a supplemental treatment unit that provides denitrification of the effluent prior to dispersal. For this reason, discharges from existing and new OWTS could potentially result in degradation of groundwater quality and adversely affect the beneficial uses of groundwater. The nitrogen in OWTS discharges to groundwater could also lead to adverse effects on beneficial uses of nearby surface waters that are hydrologically connected to the groundwater, depending on the assimilative capacity of the receiving water body and the contribution of nitrogen from OWTS relative to other sources.

### *Requirements for Use of Supplemental Treatment Components*

Sufficient denitrification is not certain to occur, even where soil conditions are conducive for nitrogen removal. With this as a backdrop, the proposed regulations would provide local agencies and the Regional Water Boards with the authority, where nitrogen removal is less predictable (e.g., sandy soils; soils overlying fractured rock; areas close to sensitive receiving waters), to provide additional protection of water quality and public health by requiring supplemental treatment systems for any existing or new OWTS that would reliably reduce the total nitrogen concentration to below the usual 10 mg/l water quality objective for nitrate nitrogen (Section 30013[a] and [d]). However, the proposed regulations would not obligate local agencies and Regional Water Boards to require denitrifying systems pursuant to Section 30013(d) except in areas within 600 feet of a 303(d) impaired water body listed for nutrients and for which OWTS have been identified as contributing to the impairment. Further, implementation of supplemental treatment systems is relatively expensive; on a widescale basis, they may be cost prohibitive. This consideration is important in balancing potential mitigation of this potential impact. Additional impacts related specifically to nitrogen and seepage pits are discussed in Impact 4.1-7.

### *Conclusion*

Under the proposed regulations total nitrogen concentrations in OWTS effluent discharged to shallow dispersal systems may not be sufficiently low, except in targeted areas of impairment adjacent to nutrient impaired water bodies and where the local agency or Regional Water Board requires OWTS to include a supplemental treatment unit that meets the water quality objective for nitrate-nitrogen in groundwater to protect water quality or public health, at least not in all cases. Thus, all new and replaced OWTS in areas other than these would have the potential to degrade groundwater quality and adversely affect the beneficial uses of groundwater and surface waters that are hydrologically connected to the groundwater. This is considered a significant impact on water quality and public health.

Mitigation Measure 4.1-5. Modify the Regulations to Include the Requirement That All New or Replaced OWTS, Regardless of the Dispersal System Design, Shall Include a Supplemental Treatment Unit That Provides Nitrogen Removal.

Section 30002 and Section 30014(k) shall be modified to include the following additional requirements:

To Section 30002 add:

(x) All new and replaced OWTS shall be designed to meet the performance requirements for supplemental treatment contained in Section 30013(b) and Section 30013(d).

and

Modify Section 30014(k) to include the additional condition that the OWTS must include a supplemental treatment unit that meets the performance requirement specified in Section 30013(d).

***Implementation:*** The implementation of Mitigation Measure 4.1-5 is the responsibility of the State Water Board.

***Significance after Mitigation:*** If Mitigation Measure 4.1-5 is implemented by the State Water Board, discharges from all new and replaced OWTS would meet the water quality objective for nitrate-nitrogen (10 mg/l) at the point of compliance. As stated above, this is a potential impact, and may not occur in all soil and groundwater conditions. If implemented, Mitigation Measure 4.1-5 would result in the need for installation of large numbers of OWTS with nitrogen removal systems designed to reliably meet the 10 mg/l total nitrogen requirement. Supplemental treatment systems are very costly; current costs range from $26,000 to $50,000 and the cost for such systems would be borne by the owners. Recognizing that complying with the new regulations may, in some cases, impose a significant monetary hardship to homeowners, the state, in cooperation with EPA has set aside funds from its State Revolving Fund Program that can be made available to local qualified agencies who can then provide low-interest loans to homeowners to either install, repair, replace, or upgrade their OWTS. The homeowners would still bear the primary financial responsibility for these improvements, but could potentially tap into lower interest (than market rate) loans. If this mitigation measure is adopted, the water quality and public health impacts associated with nitrogen contamination from operation of OWTS would be reduced to a ***less-than-significant*** level. However, if the State Water Board determines, for fiscal, socioeconomic, or other reasons, that this mitigation measure is infeasible and cannot be implemented, the impact associated with nitrogen contamination from operation of OWTS would be ***significant and unavoidable***.

IMPACT 4.1-6 **Direct Impacts Associated with Nitrogen Contamination Caused by Operation of OWTS in Targeted Areas of Impairment Next to Impaired Water Bodies with Nutrient Impairment.** *Qualified professional requirements and requirements for shallow dispersal systems would lead to improved OWTS performance. OWTS in targeted areas of impairment where the adjacent water body is listed for nutrient impairment, or listed for both nutrient and bacteriologic impairment would be required to include a supplemental treatment unit that reliably reduces the total nitrogen concentration to below the 10 mg/l water quality objective for nitrate-nitrogen in groundwater (Section 30013[d]). Therefore, total nitrogen concentrations in OWTS effluent discharged to shallow dispersal systems would be sufficiently low prior to discharge and would be sufficiently low to protect groundwater quality. These requirements in conjunction with other regulations, if necessary to implement the TMDL, would also protect surface water quality. Therefore, this impact is considered* ***less than significant****.*

In targeted areas of impairment where the water body is listed for nutrient impairment, or listed for both nutrient and bacteriologic impairment, the proposed regulations would require, in addition to all other requirements discussed previously, that all OWTS that contribute to the impairment include supplemental treatment units that have been shown to reliably reduce the total nitrogen concentration to below the 10 mg/l water quality objective for nitrate-nitrogen in groundwater (Section 30013[d]).

### *Designation of Qualified Professionals*

As discussed under Impact 4.1-3 above, the proposed regulations would require qualified professionals, as defined in Section 30000, to be involved in various aspects of OWTS siting, design, and evaluation. These requirements for qualified professionals would ensure a standard of practice that would improve the level of certainty regarding system function and performance and ensure that depth to groundwater is adequate to achieve effective soil treatment.

### *Shallow Dispersal System Design Requirements*

As previously described, the proposed regulations (Sections 30002[b] and 30014[a]) encourage shallow dispersal systems, which may enhance nitrogen removal in the soil depending on conditions in the soil receiving environment. However, because soil conditions may not be relied upon everywhere to provide adequate denitrification, discharges from existing and new OWTS could potentially result in degradation of groundwater quality and adversely affect the beneficial uses of groundwater and nearby surface waters that are hydrologically connected to the groundwater. See the discussion of Impact 4.1-5 for further details.

### *Requirements for Use of Supplemental Treatment Components*

In targeted areas next to nutrient impaired water bodies, implementation of the proposed regulations could require that all OWTS include a supplemental treatment unit that meets the performance requirement in Section 30013(d) after an initial evaluation. Thus, these systems would meet the water quality objective for nitrate-nitrogen at the point of compliance. This would reduce water quality and public health impacts associated with nitrogen contamination of groundwater and drinking water wells from OWTS in targeted areas adjacent to listed water bodies with OWTS-related nutrient impairment. This proposed requirement in conjunction with regulatory programs designed to implement the nutrient TMDL would reduce the impacts on surface water quality in targeted areas of impairment where the water body is listed for nutrient impairment.

### *Conclusion*

Under the proposed regulations, total nitrogen concentrations in OWTS effluent discharged to shallow dispersal systems would be sufficiently low in targeted areas of impairment adjacent to nutrient impaired water bodies to protect groundwater quality. The proposed requirements for denitrifying systems in conjunction with other regulations, if necessary to implement the TMDL, would also protect surface water quality. Therefore, this impact is considered less than significant.

No mitigation is required.

IMPACT 4.1-7 **Direct Impacts Associated with Nitrogen Contamination Caused by Operation of OWTS with Seepage Pits Statewide.** *Seepage pits are designed to discharge OWTS effluent to deeper soils, where the available oxygen supply is typically inadequate to facilitate nitrification of conventional OWTS effluent. Seepage pits also lack a carbon source that would facilitate denitrification of previously nitrfied effluent. Therefore, little or no nitrogen removal would be likely where conventional OWTS or aerobically treated effluent from OWTS with supplemental treatment is discharged to seepage pits. Because the proposed regulations would not require OWTS to include a supplemental treatment unit that provides nitrogen removal before effluent is dispersed to a seepage pit, nearby domestic wells hydrologically connected to groundwater receiving seepage pit effluent would be highly vulnerable to nitrate contamination, particularly in fractured bedrock environments (see discussion of Impact 4.1-4). For this reason, direct water quality and public health impacts associated with nitrogen contamination from operation of new and replaced OWTS that discharge to seepage pits is considered* ***significant****.*

As described previously under Impact 4.1-4, the proposed regulations (Sections 30014[k]) would allow the use of seepage pits for new and replaced OWTS to disperse effluent where the depth to groundwater is at least 10 feet, and shallow dispersal systems or ETI systems are otherwise not feasible because of either lack of soil depth or limited suitable area at the site. Where these conditions are met and where there is also at least 10 feet of soil below the bottom of the seepage pit and above the limiting layer, the proposed regulations would allow conventional septic tank effluent to be discharged to a seepage pit. Where less than 10 feet of soil exists below the bottom of the seepage pit, the proposed regulations would require that all new and replaced OWTS include supplemental treatment units that provide BOD and TSS removal and disinfection.

Most of the nitrogen in septic tank effluent is generally in the form of organic nitrogen and ammonia. However, these forms of nitrogen must be converted to nitrate first for denitrification to occur. Deeper soils typically lack adequate oxygen supply to facilitate the conversion of organic nitrogen and ammonia to nitrate (nitrification). Therefore, little or no nitrogen removal would be likely where conventional OWTS discharge to seepage pits. On the other hand, most of the nitrogen in seepage pit effluent from OWTS that include a supplemental treatment unit designed to remove BOD and TSS would be in the form of nitrate, since most supplemental treatment units designed to remove BOD and TSS are aerobic systems that provide effective nitrification. However, under these seepage pit conditions, little or no nitrogen removal would still be expected because even though low oxygen conditions may exist, which are critical for denitrification to occur, an adequate carbon source, also critical for denitrification to occur, would likely be lacking because the system would be discharging highly treated (low BOD and TSS) effluent to deep soils. Because the proposed regulations would not require the OWTS to include a supplemental treatment unit that provides nitrogen removal prior to seepage pit dispersal, nearby domestic wells hydrologically connected to groundwater receiving seepage pit effluent would be highly vulnerable to nitrate contamination, particularly in fractured bedrock environments (see discussion of Impact 4.1-4). For this reason, direct water quality and public health impacts associated with nitrogen contamination from operation of new and replaced OWTS that discharge to seepage pits is considered significant.

Mitigation Measure 4.1-7: Implement Mitigation Measure 4.1-5, "Modify the Regulations to Include the Requirement That All New or Replaced OWTS, Regardless of the Dispersal System Design, Shall Include a Supplemental Treatment Unit That Provides Nitrogen Removal."

***Implementation:*** The application of Mitigation Measure 4.1-7 is the responsibility of the State Water Board.

***Significance after Mitigation:*** Implementation of Mitigation Measure 4.1-7 would reduce water quality and public health impacts associated with nitrogen contamination from operation of OWTS with seepage pits to a ***less-than-significant*** level because these OWTS would be discharging effluent that would dependably meet the water quality objective for nitrate-nitrogen at the point of compliance in groundwater. The same cost issues would pertain to this mitigation as to Mitigation Measure 4.1-5. Similarly, if the State Water Board determines, for fiscal, socioeconomic, or other reasons, that this mitigation measure is infeasible and cannot be implemented, the impact associated with nitrogen contamination from operation of OWTS would be ***significant and unavoidable***.

### Direct Impacts Related to Contamination from Other Constituents of Concern

| | |
|---|---|
| IMPACT 4.1-8 | Direct Impacts Associated with Contamination from Other Constituents of Concern from Operation of OWTS Statewide. *These constituents are considered to be of secondary concern because, depending on the constituent, either not enough is known about their concentration in wastewater effluent or the characteristics that determine the transport and fate of the contaminants and the effectiveness of the properly sited and functioning OWTS systems are sufficient to attenuate the contaminants. Any additional analysis regarding the impact of these constituents on water quality and public health would be speculative because of a lack of information.* No conclusion *can be drawn.* |

Various OWTS constituents of concern have been identified (Table 4.1-1) in addition to those of primary concern (Table 2-6). These other constituents are known to occur in wastewater effluent. However, depending on the constituent, either not enough is known (numerous studies have been completed but they are inconclusive) about their concentration in wastewater effluent, and at what concentration they would adversely affect public health (e.g., traces of endocrine disruptors, pharmaceuticals and personal care products), or the characteristics that determine the transport and fate of the contaminants and the effectiveness of properly sited and functioning OWTS systems are sufficient to attenuate the contaminants, as explained in Section 2.6.2 "Occurrence of Other Constituents of Secondary Concern."

Because of the lack of or inconclusive nature of information currently available about these other constituents of secondary concern in OWTS effluent, any additional analysis regarding the impact associated with discharge of these constituents from new and replaced OWTS on water quality and public health would be speculative. The proposed regulations would not impose requirements to address other constituents of secondary concern, but further research is under way on this topic by federal and state agencies and research groups. In the future, if research indicates there is a substantial public health concern associated with these constituents, the State Water Board would consider the regulatory framework for addressing attendant issues. At this time, however, no further analysis can be conducted based on the existing information and no conclusion can be made.

No mitigation is required.

### Indirect Impacts Related to the Relaxation of Existing Local Regulations

| | |
|---|---|
| IMPACT 4.1-9 | Indirect Impacts Where Local Regulations Are More Environmentally Protective Than Those Included in the Proposed Project. *Potential changes in OWTS operations could occur if (1) local or regional agencies modify their existing regulatory requirements pertaining to OWTS siting or performance standards in subsequent and separate regulatory proceedings, (2) such changes are made partly in response to the requirements included in the new statewide regulations, and (3) the new regulatory requirements of these agencies are less stringent than their existing requirements. Such a possible future scenario could expose* |

*additional areas to adverse impacts on water quality that would not have occurred under existing local or regional regulations where such regulations are more protective than the proposed regulations. Conversely, some requirements for improvement of existing OWTS (e.g., pressurized distribution and supplemental treatment requirements) could result in positive impacts that would not otherwise have occurred because the regulations in some areas may not allow mechanical systems. Although changes to regional and local regulations could take place, it is not possible to predict where and if changes would take place, and it would be speculative to do so. Such actions would also be subject to their own CEQA compliance and would be analyzed on a case-by-case basis. Therefore this impact is too speculative for evaluation and* ***no conclusion*** *can be made.*

The current state of OWTS regulations in California is characterized by regional and local sets of regulations established by the nine Regional Water Boards, 58 counties, and a variety of cities and special districts that administer OWTS regulations. This impact would be limited to areas where (1) the requirements included in the proposed regulations differ from existing regulations, (2) local or regional agencies decide to change their own regulations in response to the new statewide regulations being implemented and related political and public pressure, and (3) the new regulatory actions taken by the local or regional agencies cause environmental impacts.

Impacts could be adverse and significant in situations where, with the new regulations in place, OWTS effluent contaminant concentrations would exceed water quality objectives and/or the significance thresholds related to public health. For example, the vertical separation to groundwater requirements for conventional systems are more than the 3 feet requirement pursuant to the proposed regulations (Section 30014[c]) in Water Board Region 2 (3–5 feet), Regions 3, 5, and 6 (5 or more feet), and Region 9 (9–14 feet). Regions 1, 2, 3, 6, and 9 have specific requirements for maximum ground slope for siting of dispersal fields. No specific ground slope requirements exist in the proposed regulations. Potential changes in OWTS operations could occur if local or regional agencies take new actions in response to the new statewide regulations being implemented. One scenario could be that more stringent and existing requirements such as those above are replaced (in subsequent and separate regulatory proceedings) with less stringent regulatory requirements for separation to groundwater, such as those included in the proposed regulations. In situations where this scenario may occur, OWTS could be permitted in additional areas that do not currently allow them, resulting in adverse and significant impacts.

On the other hand, impacts could be positive under other scenarios. For example, local agencies or the Regional Water Board may require supplemental treatment systems for any existing, as well as new, OWTS where treatment is needed to mitigate insufficient soil depths, pursuant to Section 30013[a]. Other jurisdictions that currently may not allow mechanical pumps, pressurized distribution, or certain supplemental treatment units for onsite wastewater treatment, may change their regulations to encourage shallow dispersal and use of supplemental treatment units. With required improvements for existing systems, this would result in positive impacts in areas where the proposed regulations lead to an improvement in the water quality of OWTS discharges, as health risks would decrease and violations of water quality objectives would not occur.

Although adverse and significant scenarios or positive scenarios could occur under the proposed regulations, it is not possible to predict what new actions local or regional agencies with currently more stringent regulations would take in response to the new regulations, or where and if such actions would take place. Attempting to do so would be speculative. Section 15145 of the CCR states that “where future development is unspecified and uncertain, no purpose can be served by requiring an EIR to engage in sheer speculation as to future environmental consequences.” Actions taken by local or regional agencies to change their regulatory requirements pertaining to OWTS operations such that they would be made less stringent to comply with the proposed statewide regulations would be discretionary and not caused by the proposed regulations; further, any such actions would be subject to their own CEQA compliance if these changes could have a significant effect on the environment, pursuant to Section 15064 of the CCR. These actions would be evaluated on a case-by-case basis.

Because additional impact assessment or mitigation of indirect operational impacts on water quality and public health in unimpaired areas is not appropriate based on the above mentioned criteria, and because such actions would be subject to their own CEQA compliance and would be analyzed on a case-by-case basis, this impact is too speculative for evaluation. Therefore, no conclusion can be made.

No mitigation is required.

### Indirect Impacts Associated with Mandatory Septic Tank Inspections

IMPACT 4.1-10 Indirect Impacts Associated with Increased Septic Tank Pumping, Septage Hauling and Treatment, and Biosolids Hauling and Treatment Statewide. *The proposed project's regulatory requirement concerning mandatory septic tank inspections is expected to result in an increase in the frequency of septic tank pumping relative to existing conditions. An increase in the frequency of septage pumping, transport, and treatment at centralized treatment plants and an increase in septage treatment leading to more biosolids disposal have the potential to result in indirect water quality impacts. However, the increase in frequency of pumping would not be expected to substantially increase the total septage discharged at treatment plants. The increased transport of septage from individual OWTS to centralized wastewater facilities has the potential to cause adverse water quality impacts, especially in the event of an accident during transport or handling of septage. However, local agencies regulate individual septage haulers through transportation safety regulations. The increase in biosolids requiring treatment and disposal would not likely be substantial relative to existing quantities, and the General Order for Waste Discharge Requirements for the Discharge of Biosolids to Land for Use in Agricultural, Silvicultural, Horticultural, and Land Reclamation Activities in California (General Order), adopted in August 2000 (Water Quality Order No. 2000-10-DWQ) includes provisions that ensure the safety of biosolids transport. Additionally, local agencies regulate individual septage haulers through the same types of regulations as those indicated in the General Order. This impact would be* ***less than significant****.*

Currently, OWTS owners are under no specific requirement to inspect their tanks and may check them less frequently than every 5 years. Assuming full compliance, the requirements of the proposed regulations for septic tank inspections at least every 5 years pursuant to Section 30002(u) would most likely lead to more frequent septic tank pumping. Increased frequency of pumping could marginally increase the volume of septage produced by OWTS; by increasing the frequency of pumping, there may be less residence time for waste in the septic tank, leading to potentially less digestion. Total septage volumes generated from OWTS pumping may be higher than under current regulatory conditions, but the addition would not be expected to be substantial. The same quantity of untreated effluent would be input to the tanks. In all cases (current and under proposed regulations), pumped septage must be transported to a central treatment plant for treatment and disposal. This section addresses the potential indirect water quality impacts associated with an increase in septic tank pumping and septage transport and treatment at centralized treatment plants. Another issue covered in this section is the potential for an increase in septage treatment leading to more biosolids disposal.

#### *Increased Septage Treatment*

Most OWTS owners currently do not inspect or pump their septic tank as frequently as recommended to ensure proper operation and avoid system failures. Mandatory and more frequent inspections would address this problem. An increase in the frequency of septic tank pumping would add marginally to the quantity of septage treated at centralized wastewater treatment facilities that receive septage. It is not known if the increase in septage would substantially affect capacity at any treatment plant, but it is possible.

However, under the ongoing WDR program, the individual Regional Water Boards regulate the quality of wastewater treatment facility discharges. WDRs generally identify limits on allowable concentrations and/or mass emissions of pollutants contained in the discharge, prohibitions on discharges not specifically allowed under the permit, and provisions that describe required actions by the discharger, including industrial pretreatment, pollution prevention, self-monitoring, and other activities. When wastewater is discharged to a water body, the WDRs serve as NPDES permits. The Regional Water Boards in California are responsible for implementing

WDRs and the NPDES permit program, and any expansion of centralized wastewater treatment facilities caused by increases in OWTS septage would be required to provide treatment at the same level of effluent quality as all other effluent; thus, no substantial change in water quality would be expected. This impact is considered less than significant.

### *Septage Transport and Disposal*

The additional transport of septage from individual OWTS to centralized wastewater treatment facilities would add the potential for spillage and contamination of surface water or groundwater during the process of pumping septage from the system, transportation to the facility, transfer of septage to the facility, and transport of biosolids to receiving areas. Local agencies regulate septage haulers through transportation safety regulations. The California Department of Transportation imposes standards on container trucks that include many of these requirements. Septage haulers deliver septage to facilities that are regulated by WDRs, NPDES Permits, or Title 27 standards and federal regulations under 40 CFR Part 503 (which control biosolids operations), which also apply to septage. For these reasons, the proposed project would likely only cause a minor increase in the likelihood of accidents during septage-related transport and handling, and therefore, proposed project-related impacts of septage hauling on water quality as a result of implementation of the proposed regulations are expected to be less than significant.

### *Biosolids Transport and Disposal*

The General Order (Water Quality Order No. 2000-10-DWQ) adopted by the State Water Board in August 2000 defines biosolids as sewage sludge that has been treated and tested and shown to be capable of being beneficially and legally used as a soil amendment for agriculture, silviculture, horticulture, and land reclamation activities as specified under 40 Code of Federal Regulations (CFR) Part 503. The General Order establishes a notification and permit review process applicable to all persons and public entities intending to apply biosolids to land for the purposes stated above. The General Order defines discharge prohibitions, discharge and application specifications, storage and transportation requirements, and general procedures and provisions to which all land appliers must adhere.

The additional quantity of biosolids produced by centralized wastewater treatment facilities following septage treatment would increase the potential for spillage and contamination of surface water or groundwater during the process of transporting biosolids to receiving areas. The General Order includes numerous provisions that ensure the safety of biosolids transport. The proposed General Order requires that the biosolids hauler be trained in spill response procedures designed to prevent spilled biosolids from remaining on roads, being washed into storm drains or waterways, or contaminating groundwater. Specifications in the General Order mandate that each truck carry a copy of an approved spill response plan.

No mitigation is required.